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Coal Conversion at Picatinny Arsenal and Forts Campbell, Bragg, and Gordon: A Feasibility Study

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by
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FOREWORD

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The research was performed by the Energy and Utility Systems Division (FE), of the Infrastructure Laboratory (FL), of the U.S. Army Construction Engineering Research Laboratories (USACERL). Dr. Mike C.J. Lin was the USACERL principal investigator. Dr. David M. Joncich is Chief, USACERL-FE, and Dr. Michael J. O'Connor is Chief, USACERL-FL. The USACERL technical editor was William J. Wolfe, Information Management Office.

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LTC David J. Rehbein is Commander of USACERL and Dr. L.R. Shaffer is Director.

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COAL CONVERSION AT PICATINNY ARSENAL AND FORTS CAMPBELL, BRAGG, AND GORDON: A FEASIBILITY STUDY

1 INTRODUCTION

Background

The fiscal year 1986 (FY86) Defense Appropriations Act (PL 99-190) Section 8110 directed the Department of Defense (DOD) to establish a program to increase the use of coal at facilities in the United States to a target of 1.6 million short tons per year,* over the 1985 coal consumption level, by 1994. The FY87 Appropriations Act (PL-500) Section 9099, continued this direction to implement the coal use program, and stipulated that such action should use the most life-cycle cost-effective fuel system. The language further stated that 300,000 tons of this amount should be anthracite coal. Subsequent Acts (FY88 PL 100, Section 8113, and FY89 PL 100-463, Section 8126) retained the direction toward the FY94 target for increased coal consumption, but added that the Department of Defense must comply with the life-cycle cost effectiveness criteria requirements of 10 USC 2690. House Report HR-101-345, accompanying the FY90 Defense Appropriations Act, stated that, "As a related issue, the conferees agree with Senate report language which directs the Department to continue, without modification, its efforts to increase domestic consumption of coal as outlined in the Department's letter signed by the Assistant Secretary of Defense for Acquisition and Logistics, dated August 30, 1985." To help the Army comply with these requirements, the U.S. Army Engineering and Housing Support Center (USAEHSC) requested that the U.S. Army Construction Engineering Research Laboratories (USACERL) provide technical studies and support for the Army's coal conversion program.

In general, coal is cheaper than gas or oil on a per-Btu basis, but coal-fired plants require considerably more capital and have higher operation and maintenance (O&M) costs due to coal/ash handling equipment and air pollution control devices not required with other fuels. A series of screening and life-cycle cost-estimating models have been developed to determine when and where specific coal combustion technologies could be implemented. Those specific plants that can be cost-effectively converted to coal (most likely the larger heat plants) must be identified. The first step in identifying and ranking potential sites for coal conversion is to collect information from installation heating plants and to conduct computer analyses with screening and costing models.

Objective

The objective of this study was to determine the technical feasibility and cost-effectiveness of converting selected central heat plants to coal-firing capability at four Army installations.

Approach

A literature search was done to locate other coal conversion studies, and an Air Force coal conversion study was reviewed. Criteria for selecting four installations for a detailed study were

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* A metric conversion table is included on p 23.

formulated, and Army installations were evaluated and scored accordingly. Based on the scores obtained from the evaluation, final selections were made. The selected installations were visited, and detailed plant data was collected. Plants were evaluated for possible coal conversion using the CHPECON and Status Quo software programs. The results of the evaluations were compiled and recommendations were made.

Scope

This work investigated the feasibility of coal conversion for four selected Army installations at a given point in time. Specific conclusions, recommendations, and cost estimates were based on assumptions (e.g., future base energy requirements, fuel price, and price escalation factors) that will likely change with time and advances in technology. However, the methodology and procedures used in this study can be extended to other federal facilities for similar studies.

2 COAL CONVERSION FEASIBILITY STUDY

DOD Coal Use and the Potential Conversion Sites

Table 1* lists the total DOD coal consumption during the past 7 years, including coal consumption in the Army, Air Force and Navy. To meet the Congressional directive, the DOD has to more than double its coal usage. The increase in coal use at the DOD, however, has not been significant since 1985. In 1991, the DOD consumed 3.4 percent more coal than it did in 1985. The Army consumed the largest amount of coal of the three services with about a 9 percent increase in coal consumption in 1991–the majority of which was used in facilities at the Army Materiel Command. However, the Navy's consumption increased only 3.2 percent, while Air Force consumption actually fell by 3.7 percent.

A survey conducted at the DOD identified the potential coal conversion sites. Table 2 lists the name and the potential increase in coal use for each sites (Salthouse 1987). The listing shows the Navy to have the highest potential for increased domestic coal consumption.

Review of Air Force Coal Conversion Work

The Air Force had contracted Oak Ridge National Laboratory (ORNL) for a coal conversion study.** The results indicated that coal firing was not economical for smaller industrial and commercial heating plants or plants with low load factors. A minimum value for annual fuel use was identified as a cut-off point (260 BBtu/year or 30 MBtu/hr average). Any plant using less fuel was dropped from consideration in the study. Heating plants known to have no boilers larger than 10 MBtu/hr were also eliminated. Only gas/oil-fired heating plants with an aggregate boiler capacity of 50 MBtu/hr or greater were considered. Twenty seven plants were found in 24 Air Force bases that met the capacity and fuel usage criteria. (The ORNL study listed only 18 coal burning plants in the Air Force.) There were three types of possible projects:

1. Those that use coal firing to meet base steam load, and gas/oil during high demand period
2. Those that use coal firing for all steam generation, but include a gas/oil backup burner
3. Those that cogenerate electricity and steam.

The first ORNL study (Wilkinson 1989) focused on category 1, using a commercial software package (Framework II)*** to develop a costing program that used algorithms based on recent cost studies, vendor information, and applicable reported costs of actual coal utilization projects. The program assumed conversion or replacement of one to three existing boilers with the same capacities. Sulphur dioxide (SO_2) and nitrogen oxide (NOx) emission regulation standards are assumed to be met by using low sulfur coal with good combustion control. A baghouse was assumed for particulate control. Economic evaluations were performed for the 27 heating plants and the results were presented. Micronized coal firing was found to be the most economic system. The ORNL report cautioned that more in-depth study would be needed to confirm this technology as the current best choice. The break-even gas/oil prices for all the plants ranged between 2.63 and 5.69 $/MBtu. Ten heating plants showed cost savings (from 14.4 percent to 0.6 percent) using micronized coal technology.

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* All tables are included in Appendix A to this report; all figures are included in Appendix B.

** The ORNL study produced four reports, cited fully in the reference section of this report (p 24): Griffin, et al. 1989; Holcomb and Griffin 1990; Thomas and Young 1989; and Wilkinson 1989.

*** Framework II is a registered trademark of Ashton Tate, 20101-T Hamilton, Torrance, CA 90413, tel. 213/292-1374.

This coincides with other Air Force studies that found these plants to be among the 12 sites recommended for further study, even before ORI/Guernsey performed the economic analysis (ORI, Inc. and C.H. Guernsey 1988) ORI/Guernsey selected seven Air Force Bases for detailed coal conversion study: Elmendorf, the U.S. Air Force Academy, Hill, Kelly, Robins, Arnold, and Plattsburgh. All seven of these AFBs were sites of heating plants selected by ORNL. The ORNL study concluded that conversion of 18 heating plants to coal would be required to meet Air Force's target of 600,000 tons additional annual coal consumption. This study also concluded that, to be cost effective, larger cogeneration projects must be considered.

A recent ORNL study (Holcomb and Griffin 1990) used approaches adopted by USACERL, and followed the life-cycle costing method and evaluation procedures set forth in the Federal Energy Management Program Rules. Both coal refit technologies and replacement boilers were considered. The study considered the following refit technologies: micronized coal-firing units; slagging pulverized coal burners; modular fluidized bed combustor (FBC) add-on units; stoker firing units; coal/water slurry, and coal/oil slurry units; and low-Btu gasifiers. Replacement boilers include packaged shell stokers, packaged shell FBCs, field-erected stokers, field-erected FBCs, pulverized coal boilers, and circulating FBCs. Results showed that, with micronized coal technology, it was economical to refit 15 heating plants at 15 Air Force bases. The benefit/cost ratio (the life-cycle cost [LCC] for continued gas/oil firing to the LCC for the coal utilization project) ranged between 1.262 and 1.039. After careful examination, 16 plants at 16 bases (Elmendorf, AK; Tinker, OK; Hill, UT; Robins, GA; Plattsburgh, NY; McGuire, NJ; USAF Academy, CO; Hanscom, MA; Arnold, TN; Grand Forks, ND; Andrew, MD; Kelly, TX; Minot, ND; Scott, IL; Dover, DE; and Pease, NH) were selected for possible coal conversion. If the coal projects were implemented in the 16 selected sites, an additional 334,800 tons/year coal consumption in Air Force would be achieved. The ORNL study concluded that cogeneration, plant expansion, and other types of projects must be explored as ways to expand coal use.

In October 1990, ORNL published cogeneration economic analysis results for seven Air Force bases (Hill, McGuire, Plattsburgh, Kelly, Griffiss, Grissom, and Wright-Patterson). The report recommended that feasibility studies of coal-fired cogeneration plants should be initiated for the three leading candidate bases: Hill, McGuire, and Plattsburgh. The benefit/cost ratios ranged between 1.25 and 2.82 based on the 10 percent Air Force financing method. It would consume additional 340,000 tons of coal per year.

ORNL recently assessed energy plant options for McGuire Air Force Base. Four options were considered: (1) to renovate the existing gas-fired boiler, (2) to build a new baseload (50 MBtu/hr) coal-fired heating boiler, (3) to build a coal-fired cogeneration steam plant (2x10 MWe*), and (4) to build a gas turbine cogeneration plant (3x6 MWe). Results indicated that a coal-fired heating boiler was economical, but a coal-fired cogeneration plant was not. A gas turbine cogeneration plant showed a small economic benefit (benefit/cost ratio about 1.08). A similar assessment at Andrews Air Force base showed that use of a new coal-fired heating boiler would be economical (benefit/cost ratio 1.45). Renovation and conversion to gas showed a small benefit (benefit/cost ratio 1.07). Neither a coal-fired cogeneration plant nor a gas turbine cogeneration plant were economical.

Other results from the several reports on the ORNL study were somewhat internally inconsistent, and more examination will be required to resolve the discrepancies between the several reports generated from the study. For example, one study on micronized coal retrofit (Thomas and Young 1989) assumed an unrealistically low price for a high quality fuel (1.5 $/MBtu for coal with 0.1 percent ash and 0.25 percent sulfur).

* MWe = MegaWatts of electrical generating capacity.

ORI Inc./C.H. Guernsey and Co. also conducted a study (1988) for the Air Force to evaluate the potential for applying conventional coal technology at 34 Air Force Bases. The study considered conversion or reconversion of existing boilers capable of burning coal, and the replacement or addition of new coal-fired boilers. The study also analyzed the 34 bases and identified candidates ranked by their potential for development of coal-fired facilities. An economic evaluation model was developed and applied to the candidate bases.

Each base considered was evaluated for its potential to develop four alternative types of coal-fired central heating plants, by: (1) reconverting to coal, (2) adding a coal boiler, (3) constructing a new coal boiler at a new site on-base, or (4) constructing a new coal boiler at a new site off-base. Also considered was the potential to develop three alternative coal-fired cogeneration plants: (1) a cogeneration unit at existing CHP, (2) a cogeneration unit at a new site on-base, and (3) a cogeneration unit at a new site off-base. A matrix was developed to screen the bases using the following categories: (1) coal availability, (2) coal-firing suitability, (3) cogeneration potential, and (4) environmental acceptability. The total possible points for each category was 100.

Points were assigned in the evaluation matrix as follows:

A. Coal availability to base:
1. Rail - Long Haul (20 points)
2. Rail - Short Haul (40 points)
3. Truck (40 points)

B. Coal capability of existing heating plant:
1. Boilers suitable for coal (Yes/No)
2. Plant expansion space (20 points)
3. Site for coal storage (20 points)
4. Site for cooling tower (10 points)
5. Rail access (10 points)
6. Truck access (10 points)
7. Coal-handling equipment (10 points)
8. Coal preparation equipment (10 points)
9. Ash-handling equipment (10-points)
10. Ash disposal (10 points)
11. Existing coal capability vs. load (10 points)
12. Water supply (10 points)
13. Access to central heating system (30 points)
14. Steam/hot water load characteristics (10 points)
15. Access to electric utility (10 points)

C. Cogeneration potential:
1. Electric utility acceptance (50 points)
2. Facility electric load (50 points)

D. Environmental
1. Air field operations (10 points)
2. EPA air quality compliance (30 points)
3. Wastewater discharge (20 points)
4. Noise (20 points)
5. Aesthetics (20 points)

Seven candidate bases were selected for economic analysis based on the matrix ranking: Elmendorf, USAF Academy, Hill, Kelly, Robins, Arnold, and Plattsburgh. Site visits were conducted and final matrix evaluations were made. Four of the candidate bases (Elmendorf, Robin, Arnold, and Plattsburgh) were ranked highly. The lowest total facility charges for conventional coal-fired installations at highly ranked candidate bases with 600,000 tons per year of coal consumption were:

Base	Alternative	Coal Usage (Tons/year)
Plattsburgh AFB	Co-gen, 17 MW	102,200
Elmendorf AFB	Co-gen, 22.5 MW	165,865
Arnold AFB	Co-gen, 75 MW	341,200
	Total	**609,765**

The ORNL and ORI/C.H. Guernsey study gave preliminary results only, and indicated that further engineering study may be warranted to confirm the economics.

Screening and Cost Estimation Tools

Army Installation Inventory Program

The first step to identify the potential Army sites for coal conversion is to collect the energy consumption data for each installation. The data can be obtained from the Defense Energy Information System (DEIS). This system was established to obtain energy consumption, inventory, and cost data from the services. The Department of the Army (DA) requires all Army installations to submit data to the Army DEIS Data Entry System (ADDS). Energy consumption is reported twice each month. The report is used at all levels of government for energy conservation evaluation and energy-related budgetary, procurement, and operational planning and decisionmaking. Appendix C lists the 1989 ADDS energy consumption report for the 226 Army installations in order of decreasing energy usage. Only installations located in the continental United States were considered for coal conversion. Table 3 lists 45 installations with average energy consumption of greater than 38 MBTU/hr in order of decreasing energy usage. For many installations, detailed heating plant data are not available. The initial focus of this study was to select four installations from the list for detailed feasibility studies.

Data on the selected installations was available through USACERL's Army Facility Energy Systems Inventory Program (INV) database, which was begun and has been updated since 1990. This inventory program is designed to hold energy and utility systems information for Army installations. This data can be used for reports about individual installations, to extract information about a large number of installations, or to supply data to other computer programs for further analysis. In the summer of 1990, a survey was distributed to installations in all the Army major commands (MACOMs) requesting detailed information about each installation, its heating plants, and its boilers. General information about each installation includes:

1. Building and land inventory
2. Climate and location information
3. Types of energy available, costs, and annual usage
4. Master planning information for the next 10 years
5. Information about emission standards.

The database resides on an IBM-compatible personal computer (PC). On starting the program, the user selects an installation from the list of 142. Through a series of pull-down menus and screens, the

user can view data on all aspects of the installation's energy systems. A report section enables the user to print out data on individual installations.

One important function of this database is to allow rapid access of energy and utility information for all the listed installations. The inventory programs have prewritten reports that enable the user to extract data by boiler manufacturer, size, fuel, age, and type of construction. The data itself is stored in dBase® format, a common personal computer database file format widely known and accessible via custom programs written by any programmer familiar with dBase software. Another important use of this data is to supply information for evaluating heating plant options.

CHPECON Program

The Central Heating Plant Economics Evaluation Program (CHPECON) is a USACERL-developed computer program that provides the ability to perform evaluations of the life cycle costs of heating plants with Plant Maximum Continuous Ratings (PMCR) between 50 and 600 MBtu/hr comprised of individual boilers ranging from 20 to 200 MBtu/hr. Heating plant fuel choice includes coal, gas, and/or oil.

The first step in performing an economic evaluation with CHPECON is to provide answers to the screening models. The screening model allows the user to determine the suitability of an installation for a boiler plant of a particular technology. The evaluation can be performed for one of the following configurations:

- new plant
- new plant with cogeneration (of electricity)
- new plant with third party (outside ownership) cogeneration
- new plant with consolidation of existing plants
- retrofit of a heavy oil plant with a different technology.

The screening model data requirements include choice of military installation being studied, average monthly heating load, boiler technology, and fuel type. The boiler technology choices include:

- dump grate spreader stoker with or without fly ash reinjection
- vibrating grate spreader stoker with or without fly ash reinjection
- reciprocating grate spreader stoker with or without fly ash reinjection
- travelling grate spreader stoker with or without fly ash reinjection
- travelling grate stoker
- chain grate stoker
- coal-oil slurry
- coal-water slurry
- bubbling bed
- circulating bed
- gas/oil fired boilers.

The screening model also includes general questions about the plant, used to calculate a feasibility score that reflects the probability that the proposed plant can be constructed and operated economically. Appendix D lists the information needed to run the CHPECON program using the screening and costing models. Appendix E contains an example screening model report.

The second step in completing an economic evaluation of a facility is to run the cost model option of CHPECON. The cost model calculates costs for a plant using the screening model data. Cost model inputs include fuel prices, the fiscal year of evaluation, current escalation and discount rates, and the

expected life of the plant. The cost model calculates the cost of boiler fuel including transportation, auxiliary energy, operation and maintenance, and repair and replacement over the life of the plant. The cost model report includes itemized plant component costs, capital investment costs, year-by-year operating costs, total life cycle costs, and levelized plant costs (in $/MBtu and $/1000 lb steam). Appendix F contains an example long-form cost model report. Appendix G contains the shorter cost model report that summarizes the plant costs from the long form.

CHPECON offers two special options to expedite the analysis of plant options, the multiple run analysis, and the sensitivity analysis. Multiple run analysis allows the user to run combined screening/costing models for all the appropriate coal-fired technologies, and provides a list of life-cycle costs for all the technologies in order of increasing cost. Sensitivity analysis automatically varies eleven parameters to show their effects on the plant costs. The eleven parameters are: (1) primary fuel initial cost, (2) primary fuel escalation rate, (3) auxiliary energy cost, (4) O&M labor cost, (5) O&M non-labor cost, (6) repair/replacement cost, (7) initial investment cost, (8) existing salvage value, (9) new salvage value, (10) discount rate, and (11) plant life.

CHPECON uses seven databases: (1) coal field information, (2) acceptable coal properties (for combustion technology options), (3) military installation information, (4) boiler stack emission regulations, (5) equipment emission factors, (6) construction productivity and wage data, and (7) operations labor staffing and wage data. These databases can be updated from within the CHPECON program by choosing the "update databases" option. The system utilities option allows the user to set screen colors, set printer margins, reindex files, rebuild a case list from present files, read in new LCCID (Life Cycle Cost in Design) cost information, or set the values for sensitivity analysis.*

Both the inventory program and the CHPECON program are currently being modified so that CHPECON can extract data directly from the inventory program. This will enable analysis of future energy supply alternatives according to the most up-to-date data available.

CHPECON Costing Validation

Boiler cost data was compiled from the CHPECON program, the equations in the CHPECON manual, and from *Population and Characteristics of Industrial/Commercial Boilers in the U.S.* (USEPA 1979). Table 4 presents boiler cost data and Table 5 presents CHPECON cost validation data.

The boiler costs reported by the EPA in 1979 were escalated from 1979 dollars to 1991 dollars by using economic indicators from *Chemical Engineering* and *Engineering News Record.* In Table 4, the plant cost indexes for 1979 and the third quarter of 1991 were used to calculate a multiplier of (360.9/238.7) to escalate the cost of capital and fixed costs in Table 5 from 1979 dollars to 1991 dollars. The multiplier used to escalate O&M costs in Table 5 was (4538.8/2661.5). The multipliers should provide an accuracy of ±25 percent.

Individual boiler costs for various technologies and fuels from the USEPA study (1979) and CHPECON equations are compared in Table 4. Table 6 lists the items included in the boiler costs shown in Table 4. The values calculated with the CHPECON equations are reasonably accurate, though the CHPECON estimates rely on the plant maximum continuous rating (PMCR) and do not account for differences in fuel quality (which may create a need for additional equipment and pollution control).

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* For more information on the Life Cycle Cost in Design program, see Linda K. Lawrie, *Development and Use of the Life Cycle Cost in Design Computer Program*, TR E-85/07/ADA162522 (U.S. Army Construction Engineering Research Laboratory [USACERL], November 1985).

The cost per MBtu was calculated from the USEPA data and compared to the cost per MBtu for a system with three or four boilers of comparable size given by the CHPECON program in Table 5. The costs per MBtu (calculated by the USEPA and CHPECON were close in the cases with gas/oil boilers, but for coal-fired boilers the value calculated from the USEPA data was much smaller than the CHPECON estimate. The discrepancy in the cost per MBtu found in the coal-fired boiler cases may be attributed to the overestimation of the cost of some subsystems (such as coal and ash handling) by CHPECON and the omission of the cost of the boiler house and air pollution control equipment and supplies in the USEPA data. Due to the frequently changing nature of market place and technologies, constant updating of costs is desirable.

Status Quo Evaluation

Before building a new plant or renovating an old plant, a status quo evaluation is needed to provide a baseline for justification of change. USACERL has developed the Status Quo evaluation program, designed to run on an IBM PC or compatible computer, which allows users to input plant data to calculate the status quo plant life cycle cost (Savoie 1992). The Status Quo database maintains an inventory of the individual parts in a central heating plant along with their installation years, costs (in a specified year), and lifespan. It also keeps a record of the typical annual costs for operating and maintenance. This data is used to calculate the projected cost of operating the central heating plant (CHP) in future years.

The Status Quo program begins with a main menu that allows the user to enter data about a particular installation, to maintain files containing default costs and life expectancy of parts, to browse the raw datafiles, and to run prepared reports.

Menus always feature a choice of possible actions. The user will need to enter data for each plant. This is done from a hand-written inventory of approximately 100 items, which comprise the components of a boiler plant, such as boilers, relief valves, and expansion tanks. The written list contains the basic specifications for each item, its installation year, and an estimate of general condition. This is entered into the computer using the "Add Data" option. Default data is supplied by USACERL with the program, including the cost and life expectancy of the component parts of the boiler plant. These items may be modified as new data becomes available.

SQLCCID Reports

The SQLCCID program is intended to help the user determine the life cycle cost of an existing central heating plant operating under status quo conditions. It runs LCCID to determine these costs based on input entered through prompt screens, and data contained in the Status Quo database.

The new plant costs calculated by CHPECON for Building 650 at Fort Campbell were compared to costs calculated by the Status Quo program. Table 7 lists the results of this comparison. To create a fair comparison, it is necessary to revise the status quo evaluation by equalizing the labor, energy, insurance, and other costs so that new plant costs are not penalized. For example, the new plant option required an operating staff of 11, while the status quo option only requires an operating staff of 7. In reality, new plants should need fewer operators due to increased automation. The revised 25-year life-cycle costs show that maintaining the status quo costs about $3 million less than building a new plant firing the same gas fuel.

Installation Selection Criteria and Ranking Scores

To help choose the installations for a detailed study, criteria were selected and used to compare installations. A point was assigned to each installation for each met criterion according to information

collected in the inventory surveys. Table 8 shows the criteria and the points assigned. The points were summed to determine the composite score for each installation, and the installations with high scores were considered for final selection.

The installations being considered for the coal conversion study and the relevant information are shown in Table 9. The actual points and composite scores for the installations are shown in Table 10. These scores were taken into consideration when selecting the four installations for detailed coal conversion studies.

Final Selection of Four Installations

Four installations were chosen for detailed study: Fort Campbell, Fort Bragg, Fort Gordon, and Fort Carson. Factors taken into consideration are ranking scores, installation service function (FORSCOM, TRADOC, AMC, and others), geographic location (DOE regions), recent installation fuel contracts, etc. Site visits were made for the first three installations. Due to an unexpected strong objection by the Deputy Directorate of Engineering and Housing (DEH) at Fort Carson just before the scheduled visit, the trip to Fort Carson was cancelled. Since a lot of information was available on Picatinny Arsenal from previous USACERL's work, and also to include an AMC installation, Picatinny was chosen to replace Fort Carson. The following section gives the results of detailed coal conversion study.

Results of Detailed Feasibility Study

Fort Campbell

Fort Campbell is located in southwestern Kentucky in Trigg and Christian Counties and in north-central Tennessee in Stewart and Montgomery counties. The installation falls within the Clarksville-Hopkinsville Standard Metropolitan Statistical Area, (SMSA) and contains 105,347 acres. The cantonment area is located adjacent to U.S. Highway 41-A about 8 mi. north of Clarksville, TN and 17 mi. south of Hopkinsville, KY. Summers are characteristically hot and humid with mean high temperatures of 89 °F and low temperatures of 68 °F. Winters are characterized by damp, mild conditions with a mean high of 45 °F and an average minimum of 28 °F. The annual precipitation is approximately 47 in.

The major occupant of Fort Campbell is the 101st Airborne Division. Other tenant units at Fort Campbell include the U.S. Army Medical Department Activity, U.S. Army Communications Command Agency, Defense Property Disposal Office, Military Intelligence Group, and the U.S. Army Criminal Investigation Command. In addition, Campbell Army Airfield is the home of several U.S. Air Force tenant units.

The main cantonment is located on the east end of the installation on the Kentucky-Tennessee state line. The cantonment area has administration, community support, troop housing, and family housing areas. Campbell Army Airfield is located at the northeast corner of the installation. The remainder of the installation is used for training, ranges, drop zones, and landing zones. The facilities range from WWII temporary construction to recent permanent construction. The facilities serve a military population of about 22,000. In addition there are about 10,000 civilian dependents in family housing and about 5000 civilian employees at the installation. The total effective population is estimated to be about 34,000 persons. The Master Plan did not mention any major environmental problems or endangered species at Fort Campbell. However, there are minor problems with erosion caused by training activities, and with solid waste disposal areas.

The utilities at this time are well suited to serve the installation population. Fort Campbell has its own water system, which obtains good quality water from an underground artesian aquifer. The average daily consumption is between 5 and 6 million gallons per day (MGD) with peaks sometimes as high as 8 MGD. The water treatment plant has a capacity of about 9 MGD. The water storage capacity is 2.75 million gallons. The main water feeder lines are 8 to 20 in. in diameter. The sewerage system is provided by an extensive system that feeds a trickling filter treatment plant. The treatment plant effluent is discharged to Little West Fork Creek. There is apparently an infiltration problem with the collection system. The majority of the storm runoff from the cantonment area of Fort Campbell and the airfield is drained by storm sewers and open ditches into eight major drainage basins, which discharge into natural creeks. The drainage basins may limit development in some areas of the installation. In the training and range areas, the storm drainage is natural. Electrical power is supplied to Fort Campbell, except for the Lee Village housing area, by the Tennessee Valley Authority (TVA) at 67,000 volts to a main substation with a 80,000 KVA rating. The Lee Village housing area is served by the Pennyrile Rural Electric Cooperative. 12,500 volt overhead distribution lines serve the cantonment area and some ranges. Electrical loads are about 40 to 50 percent of existing capacity. The Clarksville Gas and Water Department supplies Fort Campbell with natural gas through a 10-in. high pressure line.

Fort Campbell has 5 central heating plants and 28 smaller plants. The five central heating plants are duel fueled (natural gas and fuel oil). The smaller plants operate on natural gas only. There is limited use of electricity and LP gas for heating. The thermal distribution system is mainly buried pipe. Solid waste is disposed in a sanitary landfill with an estimated life of 5 or more years.

Based on the collected information, heating plant conversion options were evaluated by running the CHPECON and the Status Quo programs. Status Quo results for the heating plants in Buildings 650, 3902, 7008, 7223, and 858 are shown in Tables 14b to 17b.

Table 11 listed the boiler fuel, capacity, year installed, and present condition (higher rating number means better condition) for each boiler in all six buildings. The heating plant in building 157 is being demolished, and therefore, no evaluation was made. Energy use data for the other five heating plants are shown in Table 12. Note that the boilers in building 7223 only operated in winter time. Annual costs for utilities, service, and supplies were estimated based on results obtained from boiler plant evaluation in Picatinny Arsenal with appropriate sizing factors. Labor costs were calculated based on total number of plant operating staff and the average pay for the designated grade levels. The total operating expense (per thousand pounds of steam) is also listed for each plant. The estimated average is 7.67 $/thousand pounds of steam, which is about 5 percent higher than the value reported by the installation (7.25 $/thousand pounds of steam). The boiler plant parts list and the results of life cycle cost analysis are presented in Tables 13a through 17a.

Results obtained from CHPECON runs on new plant option using gas, oil, or coal are shown in Tables 18 and 19 for the plants in buildings 7008 and 3902 respectively. The PMCR was set to be equal to the existing plant maximum capacity, and the fuel usage rate was set to be equal to one third of the PMCR. Only plants with capacity greater than 50 MBtu/hr can be evaluated by CHPECON program, and thus plants in building 650, 7223, and 858 were not included. The LCC ratios relative to gas fuel (set at 100) are listed in the last column of Tables 18 and 19. The tables show gas to be the least-cost plant fuel, followed by #2 oil, #6 oil, and coal. For the plant in building 7008, in terms of the LCC, a new coal-fired stoker is most costly (2.3 times of the cost of a gas-fired plant) followed by a fluidized bed combustor (FBC), a coal oil mixture (COM) fired plant, and a coal water slurries (CWS) fired plant. For the larger size plant in building 3902, a new FBC is most costly (1.92 times of the cost of a gas-fired plant), followed by stoker plant, COM plant, and CWS plant. A detailed cost sensitivity analysis for a gas/#2 oil-fired boiler plant with capacity sufficient to meet the steam demand for the whole installation is shown in Table 20. The fuel price and electricity cost are set according to the DOE region price. The parameters

used for sensitivity analysis include primary fuel initial cost, fuel price escalation rate, auxiliary energy cost, O&M labor cost, O&M nonlabor cost, repair/replacement cost, initial cost, salvage value, discount rate and plant life. Their effects on the plant LCC are plotted in Figures 1 through 6 in terms of percent change in the LCC versus percent change in parameter value. These sensitivity plots show that fuel price and its escalation rate, discount rate, and plant life have the most significant effect on the plant LCC.

The cost sensitivity analysis for a #6 oil-fired boiler plant and a coal-fired stoker plant are shown in Tables 21 and 22 respectively. The sensitivity plots are presented in Figures 7 through 18. For a coal-fired plant, the effect of fuel price change has less impact on the plant LCC while the effect of initial cost becomes important. The levelized costs of service expressed in terms of $/thousand pounds of steam, versus fuel price for gas, #6 oil, and coal are shown in Figure 19. The costs at different fuel prices are calculated from the results obtained in sensitivity analysis. For Fort Campbell, a DOE region #2 coal with a price of 1.53 $/MBtu was selected, and from Figure 19, the breakeven gas price is found to be 5.2 $/MBtu, and the breakeven #6 oil price is 5.8 $/MBtu. This means that if the coal price remains at 1.53 $/MBtu, and the gas/oil price goes above the breakeven value, then conversion to coal would make economic sense. However, for this to happen, it would be necessary to double the current gas/oil price for this region, which may require a relatively long period of time to achieve. But due to the highly volatile and unpredictable nature of fuel pricing, frequent examination of switching opportunity may be warranted. As long as the installation steam demand remains at the present level, the analysis indicates that continued use of gas as plant fuel is the best choice for Fort Campbell.

Fort Bragg

Fort Bragg is located in south central North Carolina just northwest of Fayetteville, NC. Pope Air Force Base is located adjacent and north of the main cantonment area. Camp Mackall, a subinstallation of Fort Bragg is located about 40 mi. to the west. Simmons Army Air Field is just to the east of the main cantonment. The area to the southwest is urban, and the remainder of the surrounding area is largely rural. Fort Bragg occupies an area of about 137,000 acres in Hoke, Cumberland, Scotland, and Richmond counties. With the exception of the cantonment area and scattered open areas, most of the installation is wooded. Fort Bragg has a humid subtropical climate with long hot summers and mild winters. The average mean daily ranges from 43 °F in January to 80 °F in July. Rainfall at Fort Bragg is well distributed and averages 4.7 in. per month. Snow and sleet normally fall only once or twice a winter.

The major occupants of Fort Bragg are the XVIII Airborne Corps, the 82nd Airborne Division, and the Special Operations Command. Other major tenants include the 35th Signal Brigade, the 20th engineer brigade, the First Corps Support Command, the 16th Military Police Brigade, the Dragon Brigade, and the 525th Military Intelligence Brigade. There are also community support facilities and Directorate of Logistics facilities.

The main cantonment is located on the east end of the installation near Fayetteville, NC. The cantonment area has administration, community support, troop housing, and family housing. The remainder of the installation is used for training, ranges, drop zones, and landing zones. The Camp Mackell area is used mainly for training. Pope Air Base is located to the north of the main cantonment and Simmons Army Air Field to the east. The facilities range from WWII temporary construction to recent permanent construction. The facilities serve an average population of about 64,000 with nearly 3300 buildings that total over 20 million sq ft. Historical areas at Fort Bragg include two areas that were battle sites in the Revolutionary War, and several Civil War battle sites. The installation has several endangered species, the most important of which is the red-cockaded woodpecker. Protection of the endangered species has a significant effect on future development and present use of the installation.

The 1986 Master Plan for Fort Bragg does not review the utilities, except to state that there were no problems. The potable water supply for Fort Bragg is drawn from the Little River. There is also a connection to the Fayetteville City water system. The main cantonment water treatment plant has a capacity of 10 MGD. The sewage treatment system has a capacity of 8 MGD.

Following the same procedures used for the Fort Campbell study, heating plant information is presented in Table 23 for the plants in building 4-3124, C-1432, C-7549, D-3529, E-2823, and N-6002. The first three plants produce steam while the last three produce high temperature hot water. Table 24 lists the energy use data. The plant in building C-7549 is not in use and the plant in 4-3124 is being closed; therefore, they are not evaluated. For Fort Bragg, the estimated average production cost is \$8.20/MBtu, about 27 percent higher than that at Fort Campbell (\$6.44/MBtu), and mainly due to higher gas/oil prices paid at Fort Bragg. The boiler plant parts list and the results of a life-cycle cost analysis are presented in Tables 30 through 37 for the plants in building C-1432, D-3529, E-2823, and N-6002.

Results from CHPECON runs are shown in Tables 29, 30, and 31 for the plants in building C-1432, D-3529, and N-6002. The plant capacity at building E-2823 is less than 50 MBtu/hr and thus was not evaluated.

Table 29 shows that, for the plant in building C-1432, a new coal-fired FBC has the least LCC, followed by stoker, gas, CWS, #2 oil, COM, and #6 oil. The gas and oil prices used were supplied by the base. However, note that, after Operation Desert Storm, oil prices have substantially declined. In general, large plant capacity in addition to high gas/oil prices would favor coal conversion. In this case, an average monthly steam load of 100 MBtu/hr is required to make the coal conversion worthwhile. Retrofitting the boilers for coal-stoker, CWS, or micronized coal firing can potentially result in LCC savings range between approximately \$170,000,000 and \$240,000,000 (Table 29). A more detailed engineering analysis is needed to confirm the savings since some existing equipment may need to be replaced or repaired. The CHPECON retrofit model is being enhanced to account for the fact that the estimated values from the current models tend to give higher savings due to the optimistic assumptions made in using the existing equipment.

Table 39 gives the results for the plant in building D-3529. Because the PMCR is considerably less (130,000 lb/hr), coal is no longer the cheapest fuel. Gas is the least expensive fuel followed by CWS, FBC, Stoker, #2 oil, #6 oil, and COM. For the smallest plant in building N-6002 (Table 31), gas remains the least-cost fuel, followed by #2 oil, #6 oil, and coal. As plant load decreases, coal use becomes uneconomical due to high capital investment required for coal plants. Tables 32 and 33 show the results for plants in building 4-3124 and C-7549. Gas is the most inexpensive fuel for the two plants.

Table 34 gives a detailed cost sensitivity analysis for a gas/#2 oil-fired boiler plant with enough capacity to meet the heating demand of the whole installation. The DOE region price is used for costing. The effects of the 11 parameters on the plant LCC are plotted in Figures 20 through 25. Similar to the Fort Campbell plots, fuel price and its escalation rate, discount rate, and plant life are all significant parameters.

Tables 35 and 36 give the cost sensitivity analysis for a #6 oil-fired boiler plant and a coal-fired stoker plant. The sensitivity plots are shown in Figures 26 through 31 for #6 oil plant, and in Figures 32 through 37 for coal plant. Figure 38 shows the levelized costs of service versus fuel price for gas, #6 oil, and coal. At Fort Bragg, the DOE region coal price is \$1.72/MBtu. From Figure 38, the breakeven gas and #6 oil prices would be \$3.7/MBtu and \$4.1/MBtu respectively. The breakeven prices are about 37 to 57 percent higher than the current DOE region prices. This indicates that coal could become cost competitive when gas or oil price increased by 37 or 57 percent while coal price remained the same. The likelihood that this would occur certainly would be higher than the Fort Campbell case, in which a 100

percent gas/oil price increase would have been necessary for coal to become cost effective. Plant size is the major economic driving force in switching to coal since the Fort Bragg plant is twice the size of the Fort Campbell plant (379,000 lb/hr versus 188,000 lb/hr). Note that, at Fort Bragg, the gas billing rates are $4.50/MBtu for interruptable gas and $3.92/MBtu for uninterruptable gas. The FY92 #6 oil price paid by DOD facilities is $4.41/MBtu. Therefore, based on present gas/oil price paid by Fort Bragg and the DOE region coal price, coal would be the least cost fuel when a new plant producing 379,000 lb/hr steam is to be built. However, maintaining the status quo remains cheaper than building new plants. Note that a study conducted by JRB Associates in 1982 showed that the 25-year LCC (in 1982 dollars) with the status quo was $148,787,900 while the LCC for a new boiler plant with three coal stokers was $131,078,000. The status quo evaluation done in this study (in 1992 dollars) resulted in a $155,927,643 life-cycle cost, or about 5 percent higher than the value provided by JRB Associates. The LCC for new gas plants by CHPECON runs amounts to $202,079,538, which is 30 percent higher than the status quo estimation. Based on these results, switching to coal is not recommended unless a new plant, large enough to meet the whole installation demand, is to be built. Another important issue is that complications and additional costs may be incurred in dealing with the endangered species issue (the red-cockaded woodpecker). This could significantly affect plant location and thermal distribution system design and installation.

Fort Gordon

Fort Gordon is located in the Central Savannah River Area (CSRA) of east-central Georgia, 9 mi. southwest of Augusta. The installation occupies portions of four counties (Jefferson, Richmond, Columbia, and McDuffie) with a total area of approximately 55,600 acres. The majority of the installation and the entire cantonment area lies within Richmond County, while the training areas are spread over all four counties. The climate consists of mainly warm, humid summers, and short, mild winters. The maximum recorded temperature was 109 °F. The average temperature in the winter is 50 °F. The average annual precipitation is in excess of 44 in., well distributed throughout the year. Snowfall is light and seldom remains on the ground.

The CSRA has a diverse economy based on education, defense, medical, and textile industries. The Augusta Metropolitan Statistical Area has an estimated population of about 400,000. The major occupant of Fort Gordon is the United States Army Signal Center and Headquarters of the Signal Corps. The mission of the U.S. Army Signal Center is to train military communicators in the installation, operation, and maintenance of communications-electronics equipment. The Signal Center is also responsible for development of Signal Doctrine and the corresponding organization, material, and test and evaluation requirements. A major tenant, the Dwight David Eisenhower Army Medical Center (DDEAMC) serves as the Regional Director for the Health Services Command.

The main cantonment is located on the east end of the installation. There are four main portions of the cantonment: (1) the Signal School and troop housing in the center, (2) family housing and community support areas to the southeast, (3) the DDEAMC to the northeast, and (4) the installation support areas in the west of the main cantonment. There are ranges and training areas in the center and west portions of the installation. The facilities range from WWII temporary construction to recent permanent construction. The facilities serve a military population of about 13,500 and a civilian population of about 6000. The total effective population is estimated to be about 16,000. There are no environmental considerations of major concern in the main cantonment area. There are minor problems with air quality, noise abatement, construction pollution, and wind and water erosion. Solid waste disposal may create future problems. Some of the environmental problems may change if the installation mission changes.

The utilities at this time are well suited to serve the installation population. Fort Gordon has its own water system supplied from Butler Reservoir. The water system consists of the water treatment plant with a 5.25 MGD capacity, storage facilities, and distribution and service lines. There is a problem with sludge handling from the water treatment plant. The wastewater system consists of the collection system and the wastewater treatment plant and is adequate for existing peak demands. The storm drainage system consists of pipes, and paved and channeled natural drainage ditches. The systems operate adequately for existing runoff. Electrical power is supplied to the Fort Gordon main substation by Georgia Power Company at 115 KV. Power is distributed to the installation by 12.47 KV transmission lines. There is a fuel-fired emergency motor generator to supply power to the DDEAMC. Current peak demand is about 75 percent of the rated substation capacity. The main cantonment is served by four central energy plants. The plants are duel-fueled (natural gas and fuel oil). The distribution system consists of high-temperature hot water and chilled water pipes in underground direct buried conduits, or accessible shallow concrete trenches. Future expansion of the DDEAMC may require expansion of plant "C," but otherwise the system is adequate to handle existing and proposed demands. Solid waste is disposed in a landfill with an operational life expectancy of 7 years. The current landfill complies with all federal, state, and local regulations, and is permitted and inspected quarterly by the state of Georgia.

Fort Gordon heating plant information is presented in Table 37 for the plants in building 25330, 2202, 25910, and 310. The four plants produce saturated steam by firing natural gas. The energy use data are presented in Table 38. For Fort Gordon, the estimated average production cost is \$9.15/MBtu, about 42 percent higher than that at Fort Campbell (\$6.44/MBtu), or 12 percent higher than at Fort Bragg (\$8.20/MBtu). This is mainly due to higher gas price paid at Fort Gordon. The boiler plant parts list and the results of life-cycle cost analysis are presented in Tables 39 through 42 for the plants in building 25330, 25910, 2202, and 310.

Results from CHPECON runs are shown in Tables 43, 44, and 45 for the plants in building 25330, 25910, and 2202. The plant capacity at building 310 was less than 50 MBtu/hr and thus was not evaluated.

Table 43 shows that, for the plant in building 25330, a new #6-oil fired plant has the least LCC, followed by #2 oil, gas, COM, CWS, stoker, and FBC. The gas and #2 oil prices used are supplied by the installation; #6 oil is not used in this installation, the DOE region price is used in cost estimation. For a new plant in building 25910, again, burning #6 oil resulted in lowest LCC, followed by #2 oil, COM, CWS, Stoker, FBC and gas (Table 57). It is interesting to note that gas is the most expensive fuel for this case. The LCC estimation results shown in Table 45 for plant in building 2202 are similar to those obtained for building 25330 in terms of fuel option.

A detailed cost sensitivity analysis for a gas/#2 oil-fired boiler plant with enough capacity to meet the heating demand of the whole installation is shown in Table 46. DOE region price is used for costing. The effects of the 11 parameters on the plant LCC are plotted in Figures 39 through 44. Similar to that observed in the previous two installations' plots, fuel price and its escalation rate, discount rate and plant life are significant parameters.

The cost sensitivity analysis for a #6 oil-fired boiler plant and a coal-fired stoker plant are shown in Tables 47 and 48. The sensitivity plots are presented in Figures 45 through 50 for #6 oil plant, and Figures 51 through 56 for coal plant. The levelized costs of service versus fuel price for gas, #6 oil, and coal are presented in Figure 57. At Fort Gordon, the DOE region coal price is \$1.72/MBtu. From Figure 57, the breakeven gas and #6 oil prices would be \$7.2/MBtu and \$8.1/MBtu respectively. The breakeven price is about three times that of the current DOE region price. This indicates that coal could be cost competitive when gas or oil price tripled if coal price remains at the same level. This would be an unlikely occurrence—certainly less likely than the Fort Campbell case, where a 100 percent gas/oil price

increase is necessary for coal to be cost effective. Plant size is again the major economic driving force in switching to coal—the Fort Gordon plant is only about half the size of the Fort Campbell plant (100,000 lb/hr versus 188,000 lb/hr) and one quarter of that for Fort Bragg. When compared, the results from the Status Quo evaluation and the CHPECON new plant runs show that maintaining the status quo remains cheaper than building a new plant. With plant size of 100,000 lb/hr or less, coal did not appear to be an attractive fuel.

Picatinny Arsenal

The U.S. Army Armament Research, Development, and Engineering Center (ARDEC), Picatinny Arsenal, is located in the north central part of New Jersey in Morris County about 4 mi. northwest of the town of Dover in the highlands of New Jersey. The surrounding area is suburban. The annual average temperature is 51 °F, and the maximum recorded temperature is 100 °F. The minimum recorded temperature is -20 °F. The average annual rainfall is 49 in., and the average annual snowfall is 44 in. Periods of extended extreme cold are rare, and abnormally high temperatures seldom last longer than a few days. The land area ranges in elevation from just under 700 to 1240 ft above mean sea level. The Arsenal is situated in an elongated valley tending northwest-southeast between Green Pond Mountain and Copperas Mountain on the northwest and an unnamed hill on the southeast.

In general, the areas that surround the Arsenal are suburban and summer vacation areas are located in the area's many small lakes and mountains. There are several small towns in the immediate vicinity of the Arsenal. The arsenal is within 50 mi. of several major cities and close to major transportation centers. Picatinny Arsenal covers approximately 6500 acres.

The major occupant of Picatinny Arsenal is the U.S. Army Research, Development, and Engineering Center. In addition, the headquarters of the U.S. Army Armament, Munitions and Chemical Command (AMCCOM) is located at Picatinny Arsenal. ARDEC is a subcommand of AMCCOM. AMCCOM is responsible for the life-cycle management of total research, development, engineering, product assurance, integrated logistic support, industrial preparedness, procurement, production, and material readiness for assigned systems or specific weapon systems or items. ARDEC is concerned with research, development, tests, and engineering of assigned military items and systems.

Picatinny Arsenal has three functional land areas. The south portion is roughly defined as the land between State Route 15 and the south shore of Lake Picatinny. The south portion has the main entrances, family housing, administration, research and development, industrial and maintenance engineering, inspection, supply, transportation, inert storage, and inert burning activities in the valley portion. Pilot lot operations involving explosives are performed along the slopes of the easterly hills in this area. The central portion includes the area from Lake Picatinny to Lake Denmark. The central portion has maintenance shops, explosives research and development laboratories, industrial and maintenance engineering, the power plant and testing activities. The north end has testing, inspection, and explosive storage facilities. The Arsenal has 308 acres of lakes and reservoirs, 322 acres of swamps, and 3908 acres of woods. There are about 1037 buildings and structures covering over 4 million sq ft. There are seven historical sites at the installation. The Arsenal has about 5500 civilian employees and 150 military personnel plus an unknown number of dependents in the family housing areas.

The Master Plan mentions several constraints on future development at Picatinny Arsenal. The Arsenal has various research, development, and manufacturing processes that produce a wide range of toxic and hazardous wastes. There are many known and unknown chemicals stored or buried at known and unknown sites at the Arsenal. Munitions research and testing is a primary task of ARDEC. The storage and Explosive Storage Quality Distances (ESQD) have a major effect on future development. Noise pollution can be a problem because of explosive blast noise. Because Picatinny Arsenal is within

the Northeast New Jersey-New York-Connecticut Interstate Region, control of air pollution is of major importance. The main power plant (Bldg 506) and the explosive burning ground are the major sources of air pollutants at the Arsenal. In addition, the Fish and Wildlife Program, the Forestry Program, the Agronomy and Land Management Program, and the historical sites present constraints on development.

The utilities have some trouble spots in the electrical power system and the thermal distribution system. The water system is supplied by deep wells and from surface water reservoirs. The total water demand is 170 million gal per year. A nonpotable water supply via Picatinny Lake provides water for industrial use and fire protection purposes. The sewerage system includes a collection network and a treatment plant. The treatment plant will be abandoned in the future with the installation of a pump station and pipings to the Rockaway Valley Authority sewer line. There are some individual septic tank systems. Storm water drainage at the Arsenal is furnished by a combination of natural and developed collection systems. The terrain provide natural storm drainage for most of the Arsenal. The system is adequate for the presently developed areas. Electrical power is supplied by Jersey Central Power and Light Company at 34.5 KV. The distribution system at the Arsenal operates at 2400 V. There are plans to change the distribution system to a 12.5 KV system. The electrical power system is inadequate at this time. (It is subject to frequent "Brown Outs.") There are limited emergency generation capabilities. The thermal distribution system has been the subject of recent detailed study by USACERL. It consists of a central power plant and aboveground high pressure steam distribution lines. There are several auxiliary steam plants serving limited areas of the Arsenal. Solid waste is collected by a private sanitation firm and disposed off the installation.

The Picatinny Arsenal heating plant information is presented in Table 62 for the plants in building 506, 99, and 3013. The plant in building 506 is located on the south side of Lake Picatinny and has three boilers for the production of superheated steam and electricity. The first boiler is a Riley Stoker packaged 50,000 lb/hr oil-fired unit installed in 1971. The other two boilers are Combustion Engineering units, originally designed for pulverized coal, but now firing #6 oil. Both units are rated at 160,000 lb/hr, with boiler outlet condition of 430 psig and 700 °F superheated steam. There are two steam turbine generators rated at 3 MW and 3.5 MW respectively. Since April 1988, no electric power has been generated due to the loss of the last operating turbine-generator. All the process and heating steam has been supplied through pressure reducing valves from the boiler main header.

The energy use data for building 506 plant are shown in Table 63. For Picatinny Arsenal, the estimated average production cost is $5.02/MBtu, which is the lowest among the four installations studied. This is mainly due to the low #6 oil price paid at Picatinny Arsenal ($3.01/MBtu). The boiler plant parts list and the results of life cycle cost analysis are presented in Tables 64 and 65 for the plant in building 506.

Tables 66 and 67 show results of the CHPECON runs for the plants in building 506 and 3013 respectively. The plant capacity at building 99 is less than 50 MBtu/hr and thus was not evaluated.

Table 66 shows that, for a new plant in building 506, a #6 oil-fired plant has the least LCC, followed by gas, #2 oil, COM, stoker, CWS, and FBC. The gas and coal prices used are from the DOE region price list. An average monthly steam load of 123 MBtu/hr is still not sufficient to justify conversion to coal at Picatinny Arsenal. This is different from what was found for Fort Bragg, where conversion to coal became potentially feasible at 100 MBtu/hr average load. Retrofit the boilers for coal-stoker, CWS, or micronized coal firing can potentially result in LCC savings that range between approximately $62,426,000 and $80,841,000 (Table 66). (A more detailed engineering analysis will be needed to confirm these savings since some existing equipment may need to be replaced or repaired.)

The results for the plant in building 3013 are shown in Table 53. Because of the low PMCR (50,000 lb/hr), coal is a rather expensive plant fuel. In this case, #6 oil is the least-cost fuel, followed by gas, #2 oil, COM, CWS, FBC, and Stoker. The LCC for a coal-fired plant is about twice that for a gas- or oil-fired plant.

A detailed cost sensitivity analysis for a gas/#2 oil-fired boiler plant with enough capacity to meet the heating demand of the whole installation is shown in Table 54. DOE region price is used for costing. The effects of the 11 parameters on the plant LCC are plotted in Figures 58 through 63. As observed in previous sensitivity plots, fuel price and its escalation rate, discount rate, and plant life are significant parameters.

Tables 55 and 56 show the cost sensitivity analysis for a #6 oil-fired boiler plant and a coal-fired stoker plant. The sensitivity plots are presented in Figures 64 through 69 for a #6 oil plant, and Figures 70 through 75 for a coal plant. Figure 76 shows the levelized costs of service versus fuel price for gas, #6 oil, and coal. At Picatinny Arsenal, the DOE region coal price is $1.75/MBtu, and from Figure 76, the breakeven gas and #6 oil prices would be $5.15/MBtu and $5.18/MBtu respectively. The breakeven #6 oil price is about 50 percent higher than the price paid by the installation. The possibility for this to occur certainly would be higher than the Fort Campbell case, where 100 percent gas/oil price increase is necessary for coal to be cost effective. The plant size considered for Picatinny Arsenal (250,000 lb/hr) is between the Fort Bragg plant and the Fort Campbell plant (379,000 and 188,000 lb/hr).

The LCC obtained in the Status Quo evaluation ($71,601,420) is about the same as that in the CHPECON result for a new #6 oil-fired plant ($71,021,912). A new coal-fired plant will cost about 40 percent more than the #6 oil-fired plant. Therefore, maintaining the status quo while further investigating a retrofit with coal water slurry is recommended.

3 CONCLUSIONS AND RECOMMENDATIONS

This study concludes that:

1. For all the four installations studied, the LCC of maintaining the status quo is lower than that of building new plants. This coincides with large defense cutbacks that have followed the conclusion of the cold war, when new plant construction would also become less likely.

2. When a new plant is to be built, and when that plant will have a capacity large enough to meet the demand of the whole installation, the feasibility of using coal as fuel is proportional to plant size. The larger the plant, the more likely the feasibility of coal. At Fort Bragg, for example, using coal was found to be economically feasible, but at Fort Campbell, Fort Gordon, and Picatinny Arsenal, however, coal would become attractive only if there were a significant price increase in alternative fuels: a 31 to 73 percent increase for gas, or a 50 to 84 percent increase for oil.

3. This study has found that a retrofit of Fort Bragg building C-1432's heating plant to coal-firing may result in significant cost savings. However, before undertaking this project, a more detailed engineering study may be justified.

It is recommended that a later coal conversion study:

1. Revise the economic studies (Status Quo and CHPECON runs) using updated fuel information at the beginning of each fiscal year. This will ensure that opportunities to convert to more cost-effective technologies will not be overlooked.

2. Reconcile the life cycle costs obtained from the Status Quo evaluations and the CHPECON runs to validate the cost comparison. For example, total fuel and labor costs should be in close agreement so that no individual option is penalized.

3. Obtain feedback from the installations studied (double-check) to ensure the input data are correct and the evaluations are reasonable.

4. Select heating plants in Army installations with capacities greater than 300 MBtu/hr that at one time had fired coal, to further study the economic and engineering ramifications of reconversion to coal.

METRIC CONVERSION TABLE

1 in.	=	25.4 mm
1 ft	=	0.305 m
1 sq ft	=	0.093 m^2
1 mi	=	1.61 km
1 acre	=	0.4047 hectare
1 lb	=	0.453 kg
1 gal	=	3.78 l
°F	=	(°C × 1.8) +32

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APPENDIX A:

Tables

Table 1

DOD Coal Consumption (Short Tons)

Year	Army	Air Force	Navy	DOD Total
1985	704190	452242	162095	1336261
(% of DOD)	(52.69%)	(33.84%)	(12.13%)	(100%)
1986	733490	491122	168689	1409446
1987	734457	472086	163891	1384984
1988	802218	478092	178227	1471240
1989	768962	448945	222888	1453444
1990	867690	439512	178490	1498740
1991	766725	435563	167232	1381155
(%↑vs.85)	(8.88%)	(-3.69%)	(3.17%)	(+3.36%)

Table 2

Potential Sites for Increased Coal Use
(Surveyed in 1987)

Bases	Ton/Year
Army Bases	
Iowa AAP	30,000
Fort Drum	223,000
New CumberlandAD	15,000
USMA	20,000
Fort Bragg	30,000
Picatinny Arsenel	40,000
Bayonne MOT	24,000
Redstone Arsnel	44,000
Fort Dix	25,000
Fort Knox	20,000
Fort Eustis	13,000
Lake City AAP	25,000
Scranton AAP	9,000
Fort Lewis	25,000
Fort Belvoir	15,000
Fort Greely	30,000
MDW Washington DC	67,000
Army Total	655,000
Navy Bases	
PWC Norfolk	566,000
MCDEC Quantico	23,000
NSY Norfolk	180,000
SUBASE New London	93,000
NSY Puget Sound	70,000
NAEC Lakehurst	21,000
NAS Memphis	34,000
NETC Newport	36,000
PWC Great Lakes	100,000
NATC Pattuxent River	21,000
NSY Philadelphia	157,000
MCRD Parris Island	30,000
Navy Total	1,331,000
Air Force Bases	
Malmstrom AFB	17,000
Griffiss AFB	25,000
Air Force Total	42,000
DOD Total	2,028,000

Table 3

CONUS Army Bases With Average Annual Energy Consumption > 38MBtu/hr
Period Covered: From Jan 89 Through Dec 89

	Rank	Base	# OF CHPs >50MBtu/hr	MBTU/year	Ave. MBTU/hr
1	4	Radford Army Ammo Plant***	2**	3,960,608	452
2	7	Fort Bragg	5	3,117,543	356
3	8	Fort Hood	0	2,873,759	328
4	9	Fort Knox	2	2,718,746	310
5	10	Fort Benning	?	2,717,107	310
6	12	Fort Lewis	0	2,515,574	287
7	13	Fort Campbell	2	2,425,919	277
8	15	Fort Riley	1	1,937,176	221
9*	16	Fort Ord	0	1,874,942	214
10*	17	Fort Dix	4	1,793,491	205
11*	18	Fort George Meade	1	1,719,846	196
12	19	Fort Carson	1	1,706,884	195
13	20	Fort Bliss	1	1,655,909	189
14	21	Fort Sill	1	1,649,784	188
15	22	Fort Leonard Wood	4	1,646,571	188
16	24	Fort Stewart	1	1,601,289	183
17	25	Fort Drum	1**	1,536,908	175
18	26	Fort Belvoir	1	1,351,474	154
19	27	Fort Jackson	3	1,342,532	153
20	29	West Point	1	1,289,720	147
21	30	Walter Reed Army Medical	NTE	1,254,489	143
22*	31	Fort Devens	0	1,240,232	142
23	32	Picatinny Arsenal	2	1,229,515	140
24	33	Fort Gordon	3	1,224,015	140
25	35	Fort Polk	0	1,177,156	134
26	36	Fort Sam Houston	0	1,090,090	124
27	38	Fort Rucker	0	952,015	109
28*	41	Fort McClellan	0	914,909	104
29	42	Fort Eustis	0	907,831	104
30	45	Fort Leavenworth	1	868,345	99
31	46	Red River Army Ammo Depot***	1**	867,540	99
32*	47	Fort Benjamin Harrison	1	842,345	96
33	48	Fort Huachuca	0	821,486	94
34	51	Lone Star Army Ammo Plant***	5	747,764	85
35	53	Fort Lee	0	725,970	83
36	54	Anniston Army Depot***	2**	700,806	80
37	60	Fort Mccoy	0	646,369	74
38	62	Fort Dietrick	1	630,684	72
39	64	Tooele Army Depot***	1	601,416	69
40	66	Fitzsimons Army Medical C	NTER	569,836	65
41	72	Fort Mcpherson	0	484,372	55
42	76	Fort Hamilton	0	414,203	47
43	77	Fort Irwin	0	409,088	47
44	79	Fort Myer	1	400,128	46
45	82	MTMC Mot Bayonne	1	336,471	38

* Installations recommended for closure.

** Coal is used in the CHPs. From USACERL'S INV program there are 104 CHPs with capacity >50 MBtu/hr, of which 88 CHPs firing gas/oil only.

*** AMC installation with limited inventory data available.

Table 4

Boiler Cost Data

Boiler	Fuel	Type	Capacity (MBtu/hr)	Cost per boiler ($) 1979 EPA Estimate	1991 EPA Estimate	CHPECON Equation
Stoker:			Input			
Underfeed	Coal Hi-S	Water	30	791700	1197003	1584883
Underfeed	Coal Lo-S	Water	30	679400	1027212	1584883
Chain-Grate	Coal Hi-S	Water	75	1865300	2820221	2282207
Chain-Grate	Coal Lo-S	Water	75	1639300	2478522	2282207
Spreader	Coal Hi-S	Water	150	3719200	5623206	3915500
Spreader	Coal Lo-S	Water	150	3220800	4869655	3915500
Pulverized	Coal Hi-S	Water	200	5633000	8516756	5150000
Pulverized	Coal Lo-S	Water	200	4881200	7380080	5150000
Gas/Oil:						
Oil	No. 6 Oil	Water	150	893100	1350313	951209
Oil	No. 2 Oil	Water	150	881000	1332019	951209
Gas	Nat. Gas	Water	150	832100	1258085	951209
Oil	No. 6 Oil	Water	30	274800	415481	370242

Table 5

CHPECON Cost Validation

	Fuel									
	Res Oil	Coal	Coal	Coal	Coal	Nat Gas	Dist Oil	Res Oil	Coal	Coal
Thermal Input		E low S Underfeed Stoker	E hi S	E low S Chain-Grate Stoker	E hi S				E low S Spreader Stoker	E hi S
Capacity (MBtu/hr)	30	30	30	75	75	150	150	150	150	150
Costs in 1979 (X $1000)										
Capital	797.8	1665.2	1891.3	4067.9	4554.4	2118.7	2244.9	2379.7	7804.1	8784.2
O&M	678.8	721.6	682.5	1330.5	1217.9	2035.1	2223.1	2793.9	2101.8	1849.1
Fixed	109.6	236.3	269.8	563.4	633.3	287.8	304.1	317.1	1084.5	1225.9
Escalated to 1991 dollars										
Capital	1206.2	2517.7	2859.5	6150.4	6886.0	3203.3	3394.2	3712.5	12174.9	13703.9
O&M	1157.6	1230.6	1163.9	2269.0	2077.0	3470.6	3791.2	4764.6	3584.3	3153.4
Fixed	165.7	357.3	407.9	851.8	957.5	435.1	459.8	479.4	1639.7	1853.5
Total 1991 dollars, 25-year life	34289	42214	42155	84170	82748	100846	109668	134813	142775	138875
Energy input, MBtu/year (55% load yearly)	144540	144540	144540	361350	361350	722700	722700	722700	722700	722700
Dollars/MBtu (1991 dollars, 25-year life)	9.49	11.68	11.67	9.32	9.16	5.58	6.07	7.46	7.90	7.69
Comparable system, evaluated by CHPECON	9.49	11.68	11.67	9.32	9.16	5.58	6.07	7.46	7.90	7.69
Dollars/MBtu	9.2	37.72	39.03	57.14	57.78	8.42	11.98	8.65	87.71	90.34

Table 6

Items Included in Boiler Costs (of Table 4)

Boiler pressure parts and drums
Boiler trim and soot blowers
Boiler refractory, insulation and lagging
Stoker and grate
F.D. Fan and overfire air fan
Combustion air ductwork and distribution system
Boiler convective sections
Economizer or air heater
Main steam non-return and block valve
Coal feeders
Coal distribution duct
Coal scale
Fly ash reinjection system
Ash hoppers
Boiler steel
Boiler instruments
Erection and erection supervisor
Start-up supervision
Boilout and initial operator training
Operation manuals

Table 7

Comparison of CHPECON and Status Quo Costing

Parameters	STATUS QUO	CHPECON	SQ Rev 1	SQ Rev 2
Annual labor	129476	463732	463732	463732
Annual supplies	90000	6510	6510	81987
Annual service	12162	15166	15166	15166
Annual utilities	60811	25909	25909	25909
Annual insurance	0	75477	0	Added to Supply
Sum of listed R/R costs	1143895	362299	1143894	1143894
Nat gas/oil use (MBtu/yr)	106641	119956	119956	119956
LCC of O&M	3722461	6398620	6508341	7469057
LCC of R/R	1143894	173957	1143894	1143894
LCC of Energy	6755133	9169737	7597808	7597808
Capital invest	0	3750969	0	0
LCC (total)	11621490	19493285	15250040	16210760

Note: All costs in Present Worth Value (1992 dollars)

Table 8

Base Selection Criteria and Point Assignment

Criterion #	Description	Point Assignment
1	Location of site relative to population centers	(no point)
2	Cooperation, response to previous surveys	(P=poor,2, F=fair,8, G=good,14, VG=very good,20)
3	Land available for coal/ash (no,1; some,5; yes,10)	
4	Problems related to local emission standards (ozone, CO_2, particulates, SO_2, NO_x, etc.)	(OK=20, Average=10, Poor=2)
5	Condition of present boilers	(P=poor,9, F=fair,7, G=good,5, VG=very good,3, NRNEW=nearly new,1, NEW=new boiler,1)
6	Condition of existing steam system	(P=poor,9, F=fair,7, G=good,5, VG=very good,3, RP=repairing,6)
7	Master planning notes and comments	(C=construction,6, CLCP=has coal capability,9, RP=replacement construction,5, CVEL=converting to electricity,2, RTDF=coal retrofit difficult,2, NONE=no additional comments,1)
8	Future addition/reduction in load planned	(ADD,8; RED,1; NO,1)
9	Coal burning feasible	(ACC=acceptable,9, NC=no comment,5, WOOD=will increase wood burning,3, WT=system too small,3, NORR=no rail access,3, NVB=not viable,2, UNW=unwanted,1)

Table 9

Base Selection Criteria

Base	1	2	3	4	5	6	7	8	9
Lone Star	out 35K	P-F	no	OK	O	O	NONE	NO	NC
Red River	out 35K	P-F	no	OK	O	O	NONE	NO	ACC
Fort Bragg	out 80K	VG	some	O3CO2	VG	G	C	ADD	ACC
Fort Cmpbll	rural TN	VG	yes	O3CO2SO2	P-VG	G	C	ADD	NC
Fort Carson	out 291K	VG	yes	CO2PART	NRNEW	G	C	ADD	NORR
Fort Hood	out 64K	G	yes	OK	F	G	C	NO	WT
Fort Polk	rural LA	G	yes	OK	VG	O	C	NO	ACC
Fort Riley	near 33K	VG	some	OK	G-VG	G	C	ADD	NVB
Fort Houstn	in 985K	VG	no	OK	P-NEW	G	CLCP	ADD	NC
Fort Stewrt	near 153K	F	yes	OK	G-NEW	G	CLCP	NO	WOOD
Fort Bliss	out 580K	F-G	yes	O3CO2PRT	G	O	RP	NO	UNW
Fort Eustis	out 296K	F	yes	O3	G	F	C	ADD	UNW
Fort Gordon	out 47K	G	yes	OK	G	O	C	ADD	UNW
Fort Jacksn	out 96K	G	yes	OK	F-G	F	C	ADD	UNW
Fort L Wood	rural MO	G-VG	no	OK	VG	O	C	NO	UNW
Fort MClein	out 31K	F	no	O3	G	G	RTDF	NO	UNW
Fort Rucker	rural AL	F	yes	OK	P-VG	RP	CVEL	ADD	ACC
Fitzsimns	Denver	G	no	CO2 PART	G	RP	C	ADD	NC
Fort Myer	DC area	G	no	O3 CO2	NRNEW	F	C	ADD	UNW
Bayonne	NYC area	G-VG	no	O3 CO2	F	RP	C	ADD	NC

Table 10

Points and Scores In Base Selection

Base	1	2	3	4	5	6	7	8	9	Total
Lone Star	out 35K		0	20	8	5	1	1	5	42
Red River	out 35K	2	0	20	8	5	1	1	9	46
Fort Bragg	out 80K	18	5	12	3	5	6	8	9	66
Fort Campbell	rural TN	18	10	8	6	5	6	8	5	66
Fort Carson	out 291K	10	10	12	1	5	6	8	3	55
Fort Hood	out 64K	10	10	20	7	5	6	1	3	62
Fort Polk	rural LA	10	10	20	3	5	6	1	9	64
Fort Riley	near 33K	16	5	20	4	5	6	8	2	66
Fort Houston	in 985K	16	0	20	5	5	9	8	5	68
Fort Stewart	near 153K	6	10	20	3	5	9	1	3	57
Fort Bliss	out 580K	8	10	8	5	5	5	1	1	43
Fort Bustis	out 296K	6	10	16	5	7	6	8	1	59
Fort Gordon	out 47K	14	10	20	5	5	6	8	1	69
Fort Jackson	out 96K	10	10	20	6	7	6	8	1	68
Fort Leonard Wood	rural MO	14	0	20	3	5	6	1	1	50
Fort McClellan	out 31K	6	0	16	5	5	2	1	1	36
Fort Rucker	rural AL	6	10	20	6	6	2	8	9	67
Fitzsimmons	Denver	10	0	12	5	6	6	8	5	52
Fort Myer	DC area	10	0	12	1	7	6	8	1	45
Bayonne	NYC area	10	0	12	7	6	6	8	5	54

Table 11

Fort Campbell Heating Plant Information

Plant	Boiler	Fuel	Reserve	Year Installed	Capacity (lb/hr)	In use	Rating	Energy Use Heat/Cool/ Process/Losses/ Internal/Pwr Gen
3902	1	Nat. gas	FS2	1976	15000	Y*	6	H/C
3902	2	Nat. gas	FS2	1976	50000	Y*	5	H/C
3902	3	Nat. gas	FS2	1976	50000	Y	6	H/C
650	1	Nat. gas	FS2	1982	15000	Y*	9	H/C
650	2	Nat. gas	FS2	1982	15000	Y	9	H/C
650	3	Nat. gas	FS2	1982	15000	Y	9	H/C
7008	1	Nat. gas	FS2	1985	25106	Y*	8	H
7008	2	Nat. gas	FS2	1985	25106	Y	8	H
7008	3	Nat. gas	FS2	1958	12500	N	1	H
7223	1	Nat. gas	FS2	1972	10000	Y*	6	H
7223	2	Nat. gas	FS2	1972	10000	Y	6	H
7223	3	Nat. gas	FS2	1972	10000	Y	5	H
858	1	Nat. gas	FS2	1986	11716	Y*	8	H
858	2	Nat. gas	FS2	1986	11716	Y	8	H

Table 12

Fort Campbell Energy Use Data

Fuel	Units	Btu/Unit	$/Unit	1989 Use	1990 use	$/MBtu	MBtu '90
Dist. oil	Gal	138690	0.56	1018962	631518	4.04	87585
Res. oil	Gal	149690	0.53	301266	93219	3.54	13954
Nat. gas							
Interr.	kscf						
Unintr.	kscf	1031000	3.08	1364848	1391702	2.99	1434845
Building:		650	3902	7008	7223	858	
Capacity (lb/hr):		45000	115000	62712	30000	23432	
SQ file:		CAM1	CAM2	CAM3	CAM4	CAM5	
Annual Costs							
Labor		129476	138100	94000	85600	94000	
Utilities*		60811	155405	84746	20270	31665	
Service*		12162	31081	16949	4054	6333	
Supplies*		90000	224000	125424	30000	46864	
Average Steam Production, 1990 (lb/hr):							
October		9250.0	14250.0	8541.7	0.0	4058.3	
November		10833.3	26625.0	11250.0	4083.3	4458.3	
December		14416.7	39250.0	17541.7	8687.9	7291.7	
January		12416.7	38500.0	15000.0	7375.0	4125.0	
February		16458.3	32541.7	14666.7	5616.7	4541.7	
March		12791.7	29958.3	10875.0	4600.1	4408.3	
April		10000.0	22541.7	9375.0	0.0	4133.3	
May		9166.7	6166.7	9100.0	0.0	4012.5	
June		6625.0	8041.7	11958.3	0.0	3662.5	
July		6916.7	7583.3	11916.7	0.0	3900.0	
August		5958.3	6958.3	10791.7	0.0	4075.0	
September		6833.3	5458.3	18225.0	0.0	3675.0	
Fuel energy, based on steam production, 1990 (MBtu):							
October		8291.6	12773.5	7656.7	0.0	3637.8	
November		9397.6	23096.4	9759.0	3542.1	3867.4	
December		12922.9	35183.1	15724.1	7787.7	6536.2	
January		11130.2	34510.8	13445.8	6610.8	3697.6	
February		13325.3	26347.0	11874.7	4547.5	3677.1	
March		11466.3	26854.2	9748.2	4123.5	3951.5	
April		8674.7	19554.2	8132.5	0.0	3585.5	
May		8216.9	5527.7	8157.1	0.0	3596.7	
June		5747.0	6975.9	10373.5	0.0	3177.1	
July		6200.0	6797.6	10682.0	0.0	3495.9	
August		5340.9	6237.3	9673.5	0.0	3652.8	
September		5927.7	4734.9	15809.6	0.0	3188.0	
Total		106641.0	208592.8	131036.7	26611.7	46063.7	518945.8
Percent of Total		20.5	40.2	25.3	5.1	8.9	
Reserve Fuel		#2	#2	#2	#2	#2	
Fuel use (MBtu/year):							Total
Natural Gas		99176.1	193991.3	121864.2	24748.8	42839.2	482620
Dist. Oil		7464.9	14601.5	9172.6	1862.8	3224.5	36326
Res. Oil		0.0	0.0	0.0	0.0	0.0	0
Total $/yr:		618867.9	1187071.9	722211.9	221380.4	319858.9	
$/MBtu:							

Table 12 (Cont'd)

Labor	1.21	0.66	0.72	3.22	2.04	
Utilities	0.57	0.75	0.65	0.76	0.69	
Service	0.11	0.15	0.13	0.15	0.14	
Supplies	0.84	1.07	0.96	1.13	1.02	
Fuel	3.05	3.05	3.05	3.05	3.05	Average
Total $/MBtu:	5.79	5.68	5.50	8.31	6.93	6.44
Reported $/klb steam:	7.25	7.25	7.25	7.25	7.25	

* = estimated

Table 13a

Boiler Parts Evaluation List—Fort Campbell Bldg. 650

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1978	3	15000	lb/hr			Good
1. Boiler Pressure Parts and Setting			100	psig	332	temp	Good
2. Relief Valve(s)	1978	4	1.5	in.	150	psig	Good
2. Relief Valve(s)	1991	2	1.5	in.	150	psig	Good
3. Feedwater Regulator(s)	1978	3	1.5	in.	160	psig	Good
4. Boiler Burner(s)	1978	3	70	MBtu/ft^2/hr			
5. Boiler Fan(s) (FD)	1978	3	15	Hp			
6. Boiler Economizer	1978	3	684	MBtu, 15,000 lb/hr water flow			
7. Boiler Drum Level Control	1978	3					Good
B. Feedwater System							Good
8. Deaerating Heater	1978	1	45000	lb/hr			Good
12. Condensate Pumps	1978	2	3	Hp			Good
13. Condensate Receiver	1978	1	1100	gal	(7.5'x5')		
14. Boiler Feed Pumps	1978	3	20	Hp			Good
19. Feedwater Piping System (valve)	1978	3	1.5	diam (in.)	160	psig	Good
20. Cooling Water Pumps	1978	3	60	Hp	(motor)		Good
20. Cooling Water Pumps	1978	1	62.6	Hp	(turbine)		Good
21. HTW Distribution System Pumps	City water pressure distribution						Good
C. Fuel Handling System							
1. Fuel Oil Unloading Pump	____	____	____	Hp			
2. Fuel Oil Tank - Above ground	____	____	____	gal			
3. Fuel Oil Tank - Underground	1978	1	50000	gal			
4. Fuel Oil Pump	1978	1	15	gpm			Good
5. Fuel Oil Heater	1978	2	____	gpm			
6. Fuel Oil Piping System (ABV/BLW)	1978		0.75	diam (in.)			
7. Natural Gas Piping System (BLW)	1990		2	diam (in.)			Good
D. Heat Recovery System							
E. Air Pollution Control Systems and Emission Monitoring							
5. Stack	1978	3	2	diam (ft)	25	height (ft)	

Table 13a (Cont'd)

Equipment	Year Installed	Units	Specification 1		Specification 2		Condition
F. Combustion Controls							
1. Plant Master	1978	1					Good
2. Boiler Master	1978	3					Good
3. Flame Safeguard System	1978	3					Good
4. Furnace Draft Control (DAMPACT)	1978	3					Good
5. Additional Boiler Instrumentation/ Indicators	1978			O2 TRIM			Good
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	1978	1	30	gal	0.25	Hp	Good
H. Make-up Water System							
9. Sodium Zeolite Softener	1992	2	120	gpm	(alternate use)		Good
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (CENTR/RECIP)	1978	1	16.2	SCFM	(3 Hp, 145 psi)		Good
2. Air Dryer (DESC/REFR)	1978	1	16.2	SCFM			
3. Air Receiver	1978	1	60	gal			Good
K. Electrical System							
1. Transformer	1978	2	1500/1725	KVA			
2. Switchgear -- Main Circuit Breaker	1978	2	3000	amps			
3. Motor Control Center/Starter	1979	3	300	amps			
4. Emergency Generator	1978	2	1000	KVA	(800 Continuous)		Good
L. Physical Plant							
1. Building Siding, Roofing, Windows, and Doors	1978						Good
2. Building Concrete and Building Steel	1978						Good
3. Sump Pump (SUBMERGE/ VERTICAL)	1978	1	75	gpm	(1.5 Hp)		Good
4. Building Lighting (Fluorescent)	1978						Good
Building Outside Dimensions	30 Ht (ft)		95	Lgth (ft)	132	Width (ft)	
Building Basement (Yes/No)	No						

Table 13b

Status Quo Life-Cycle Cost Analysis for Fort Campbell Bldg. 650

```
        LIFE CYCLE COST ANALYSIS                               STUDY: TDCAM1
LCCID  1.065                        DATE/TIME:    05-14-92  15:37:38
PROJECT NO., FY, & TITLE:           FY 1992       BUILDING 650
INSTALLATION & LOCATION: FORT CAMPBELL            KENTUCKY
DESIGN FEATURE:
ALT. ID. A;     TITLE: STATUS QUO
NAME OF DESIGNER:
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	30158.6	1.58	JUL93-JUL17
NATURAL GAS	296536.3	3.64	JUL93-JUL17
MAINT LABOR	129476.0	.00	JUL93-JUL17
MAINT SERV	12162.0	.00	JUL93-JUL17
MAINT SUPPLY	90000.0	.00	JUL93-JUL17
MAINT UTIL	60811.0	.00	JUL93-JUL17
STACK	18000.0	.00	JAN 18
STACK	36000.0	.00	JAN 18
DRUMCTL	15000.0	.00	JAN 98
ECONOMIZER	105000.0	.00	JAN 98
F_FAN	21000.0	.00	JAN 18
RELVALVE	6800.0	.00	JAN 98
RELVALVE	3400.0	.00	JAN 11
WTBOILER	1800000.0	.00	JAN 18
WTBURNER	150000.0	.00	JAN 18
PUMPSIMPLEX	3000.0	.00	JAN 98
TANKPOLY	200.0	.00	JAN 98
BOILMASTER	15000.0	.00	JAN 08
DAMPACT	3000.0	.00	JAN 08
FLAMESAFE	30000.0	.00	JAN 08
O2TRIM	30000.0	.00	JAN 08
PLANTMASTER	5000.0	.00	JAN 08
AIRCOMPRECIP	20000.0	.00	JAN 98
AIRDRYERREFR	12000.0	.00	JAN 93
AIRRECV	600.0	.00	JAN 08
EMERGENCYGEN	276000.0	.00	JAN 08
SWITCH	20000.0	.00	JAN 18
CONDPUMP	8000.0	.00	JAN 98
CONDREC	22000.0	.00	JAN 08
COOLPUMP	34200.0	.00	JAN 98
COOLPUMP	11400.0	.00	JAN 98
DAIRHEATER	25000.0	.00	JAN 18
FEEDPUMP	45750.0	.00	JAN 08
FWPIPINGVAL	3339.0	.00	JAN 98
NAGPIPEBELOW	13.0	.00	JAN 15
OILPIPEBELOW	25.0	.00	JAN 03
PUMP	3250.0	.00	JAN 03
TANKBELOW	42000.0	.00	JAN 08
SISOFT	231000.0	.00	JAN 12
SUMPPUMPVERT	5000.0	.00	JAN 93

OTHER KEY INPUT DATA

LOCATION - KENTUCKY   CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	4.04	7465.0		JAN93-JAN18
NAT G	2.99	99176.0		JAN93-JAN18

Table 13b (Cont'd)

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
DISTILLATE OIL	519369.	
NATURAL GAS	6478871.	
TOTAL ENERGY COSTS		6998240.
RECURRING M&R/CUSTODIAL COSTS		4260154.
MAJOR REPAIR/REPLACEMENT COSTS		1160392.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		12418790.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

LCCID 1.065 DATE/TIME: 05-14-92 15:37:38
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 650
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	28852.	284669.	277500.	16498.	0.
2	27605.	276385.	265297.	0.	0.
3	26328.	264967.	253630.	0.	0.
4	25165.	253314.	242476.	0.	0.
5	24081.	244182.	231812.	0.	0.
6	23166.	236963.	221618.	160385.	0.
7	22622.	238399.	211872.	0.	0.
8	22234.	243697.	202554.	0.	0.
9	21914.	251130.	193647.	0.	0.
10	21690.	263000.	185131.	0.	0.
11	21463.	271218.	176989.	2027.	0.
12	21206.	274010.	169206.	0.	0.
13	20935.	279887.	161764.	0.	0.
14	20561.	283054.	154650.	0.	0.
15	20110.	284282.	147849.	0.	0.
16	19570.	281212.	141347.	232007.	0.
17	18978.	274326.	135131.	0.	0.
18	18325.	270636.	129189.	0.	0.
19	17750.	263944.	123507.	1469.	0.
20	17288.	257076.	118076.	95387.	0.
21	16856.	250655.	112883.	0.	0.
22	16396.	243803.	107919.	0.	0.
23	15932.	236907.	103173.	5.	0.
24	15416.	229236.	98636.	0.	0.
25	14924.	221922.	94298.	0.	0.
***	519369.	6478871.	4260154.	1160392.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 14a

Boiler Evaluation Parts List—Fort Campbell Bldg. 3902

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1976	2	50	MBtu/hr			Good
A. Boiler (WT)	1976	1	15	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			100	psig	333	temp	Good
2. Relief Valve(s)	1976	4	4	in.	115	psig	Good
2. Relief Valve(s)	1990	2	2	in.	115	psig	Good
3. Feedwater Regulator(s)	1991	2	2-2.5, 1-1.5	in.	150	psig	Good
4. Boiler Burner(s)	1976	2	____	MBtu			
5. Boiler Fan(s) (FD)	1976	2	25	Hp			Good
5. Boiler Fan(s) (FD)	1976	1	5	Hp			Good
6. Boiler Economizer	1976	2	159000	MBtu	(on 2 larger blrs)		
7. Boiler Drum Level Control	1991	2					Good
B. Feedwater System							
8. Deaerating Heater	1976	1	7500	lb/hr			
12. Condensate Pumps	1976	1	3	Hp			Good
12. Condensate Pumps	1991	3	5	Hp			Good
13. Condensate Receiver	1976	1	10000	gal			Good
14. Boiler Feed Pumps	1976	3	40	Hp	(1-turbine, 2-motor)		Good
19. Feedwater Piping System (valve)	1976		2	diam (in.)	150	psig	Good
20. Cooling Water Pumps	1976	3	60	Hp			Good
C. Fuel Handling System							
1. Fuel Oil Unloading Pump	1976	3	30	Hp			Good
2. Fuel Oil Tank - Above ground	1976	1	1000000	gal			Good
3. Fuel Oil Tank - Underground	1976	1	20000	gal			Good
4. Fuel Oil Pump	1976	1	10	gpm	(20 Hp)		
6. Fuel Oil Piping System (BLW)	1976		2	diam (in.)			Good
7. Natural Gas Piping System (BLW)	1976		3	diam (in.)			Good
D. Heat Recovery System							
E. Air Pollution Control Systems and Emission Monitoring							
5. Stack	____	____	____	diam (ft)	____	height (ft)	

Table 14a (Cont'd)

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
F. Combustion Controls							
1. Plant Master	1991	1					Good
2. Boiler Master	1991	3					Good
3. Flame Safeguard System	1976	3					Good
4. Furnace Draft Control (DAMPACT)	1991	3					Good
5. Additional Boiler Instrumentation/Indicators	1976	2		O2 TRIM on larger blrs			Good
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	1976	5	50	gal	0.333	Hp	Good
H. Make-up Water System							
9. Sodium Zeolite Softener	1989	1	270	gpm	(185 continuous)		Good
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1976	1	48	SCFM	(15 Hp)		Good
1. Air Compressor (RECIP)	1990	2	48	SCFM	(15 Hp)		Good
2. Air Dryer (REFR)	1976	1	50	SCFM			
3. Air Receiver	1976	1	200	gal			Good
3. Air Receiver	1976	1	100	gal			Good
K. Electrical System							
1. Transformer	1993	1	2600	KVA			Good
1. Transformer	1993	1	1500	KVA			Good
2. Switchgear -- Main Circuit Breaker	1976	1	50	amps			Good
L. Physical Plan	1976						Good
1. Building Siding, Roofing, Windows, and Doors	1976						Good
2. Building Concrete and Building Steel	1976						Good
3. Sump Pump (SUBMERGE/VERTICAL)	1989	1	____	gpm	(3 Hp)		
4. Building Lighting	1976						Good
Building Outside Dimensions	____	Ht (ft)	____	Lgth (ft)	____	Width (ft)	
Building Basement (Yes/No)	____						

Table 14b

Status Quo Life-Cycle Cost Analysis for Fort Campbell Bldg. 3902

```
          LIFE CYCLE COST ANALYSIS                          STUDY: TDCAM2
LCCID  1.065                        DATE/TIME:   05-14-92  15:44:57
PROJECT NO., FY, & TITLE:             FY 1992    BUILDING 3902
INSTALLATION & LOCATION: FORT CAMPBELL           KENTUCKY
DESIGN FEATURE:
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER:
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BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JAN 92
MIDPOINT OF CONSTRUCTION (MPC)	JUL 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUL 92
DISTILLATE OIL	58992.1	1.58	JUL93-JUL17
NATURAL GAS	580033.1	3.39	JUL93-JUL17
MAINT LABOR	138100.0	.00	JUL93-JUL17
MAINT SERV	31081.0	.00	JUL93-JUL17
MAINT SUPPLY	224000.0	.00	JUL93-JUL17
MAINT UTIL	155405.0	.00	JUL93-JUL17
STACK	25000.0	.00	JAN 16
DRUMCTL	15000.0	.00	JAN 11
ECONOMIZER	140000.0	.00	JAN 96
F_FAN	7000.0	.00	JAN 16
F_FAN	23750.0	.00	JAN 16
RELVALVE	6400.0	.00	JAN 96
RELVALVE	3200.0	.00	JAN 10
WTBOILER	600000.0	.00	JAN 16
WTBOILER	1950000.0	.00	JAN 16
WTBURNER	50000.0	.00	JAN 16
WTBURNER	200000.0	.00	JAN 16
PUMPSIMPLEX	15000.0	.00	JAN 96
TANKPOLY	1000.0	.00	JAN 96
FLAMESAFE	30000.0	.00	JAN 06
O2TRIM	20000.0	.00	JAN 06
AIRCOMPRECIP	32000.0	.00	JAN 96
AIRCOMPRECIP	64000.0	.00	JAN 10
AIRDRYERREFR	20000.0	.00	JAN 91
AIRRECV	600.0	.00	JAN 06
AIRRECV	1100.0	.00	JAN 06
SWITCH	12000.0	.00	JAN 16
TRANSFORMER	38000.0	.00	JAN 16
TRANSFORMER	51200.0	.00	JAN 16
CONDPUMP	4000.0	.00	JAN 96
CONDPUMP	13500.0	.00	JAN 96
COOLPUMP	34200.0	.00	JAN 96
DAIRHEATER	55000.0	.00	JAN 16
FEEDPUMP	53250.0	.00	JAN 06
FWPIPINGVAL	1100.0	.00	JAN 96
MAGPIPEBELOW	18.0	.00	JAN 01
OILPIPEBELOW	25.0	.00	JAN 01
PUMP	4000.0	.00	JAN 01
TANKABOVE	320000.0	.00	JAN 16
TANKBELOW	26000.0	.00	JAN 06
UNLOADPUMP	23400.0	.00	JAN 96
SZSOFT	191000.0	.00	JAN 09
SUMPPUMPVERT	4900.0	.00	JAN 04

OTHER KEY INPUT DATA

```
LOCATION  - KENTUCKY                  CENSUS REGION:  3
RATES FOR INDUSTRIAL  SECTOR.   TABLES FROM OCT 91

ENERGY USAGE:   10**6 BTUS         ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE    $/MBTU     AMOUNT    ELECT. DEMAND  PROJECTED DATES
DIST             4.04    14602.0                     JAN93-JAN18
NAT G            2.99   193991.0                     JAN93-JAN18
```

LCCID 1.065 DATE/TIME: 05-14-92 15:44:57
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 3902
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
DISTILLATE OIL	1005860.	
NATURAL GAS	12388260.	
TOTAL ENERGY COSTS		13394120.
RECURRING M&R/CUSTODIAL COSTS		7872439.
MAJOR REPAIR/REPLACEMENT COSTS		1558820.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		22825380.

*NET PW EQUIVALENTS ON JAN92; IN 10**0 DOLLARS; IN CONSTANT JAN92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	55878.	544316.	512799.	0.	0.
2	53462.	528476.	490248.	0.	0.
3	50990.	506643.	468688.	0.	0.
4	48737.	484362.	448076.	226048.	0.
5	46637.	466900.	428371.	0.	0.
6	44866.	453096.	409533.	0.	0.
7	43812.	455844.	391523.	0.	0.
8	43060.	465973.	374305.	0.	0.
9	42441.	480185.	357844.	2697.	0.
10	42007.	502883.	342107.	0.	0.
11	41567.	518597.	327062.	0.	0.
12	41070.	523934.	312679.	2856.	0.
13	40545.	535173.	298928.	0.	0.
14	39820.	541227.	285782.	69769.	0.
15	38947.	543575.	273214.	0.	0.
16	37902.	537705.	261199.	0.	0.
17	36755.	524538.	249712.	88919.	0.
18	35491.	517484.	238731.	29909.	0.
19	34377.	504687.	228232.	6382.	0.
20	33482.	491555.	218195.	0.	0.
21	32646.	479278.	208600.	0.	0.
22	31753.	466176.	199426.	0.	0.
23	30855.	452991.	190656.	0.	0.
24	29856.	438321.	182271.	1132239.	0.
25	28904.	424337.	174256.	0.	0.
***	1005860.	********	7872439.	1558820.	0.

*NET PW EQUIVALENTS ON JAN92; IN 10**0 DOLLARS; IN CONSTANT JAN92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 15a

Boiler Evaluation Parts List--Fort Campbell Bldg 7088

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (FT)	1985	2	25.106	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			100	psig	333	temp	Good
2. Relief Valve(s)	1990	4	2.5	in.	150	psig	Good
3. Feedwater Regulator(s)	1985	1	1.5	in.	165	psig	Good
4. Boiler Burner(s)	1985	2	31383	MBtu			Good
5. Boiler Fan(s) (FD)	1985	2	30	Hp			Good
6. Boiler Economizer	1985	1	530909	MBtu			Good
7. Boiler Drum Level Control	1985	2					Good
B. Feedwater System							
8. Deaerating Heater	1985	1	57750	lb/hr			Good
14. Boiler Feed Pumps	1990	2	20	Hp	(with DA tank)		Good
15. Make-up Pumps	Base water supply pressure						
19. Feedwater Piping System (valve)	1985		2.5	diam (in.)	165	psig	Good
C. Fuel Handling System							
3. Fuel Oil Tank - Underground	1985	1	30000	gal			Good
4. Fuel Oil Pump	1985	2	18	gpm	(2 Hp)		Good
6. Fuel Oil Piping System (BLW)	1985		1.25	diam (in.)			Good
7. Natural Gas Piping System (BLW)	1985		4	diam (in.)			Good
D. Heat Recovery System							
1. Blowdown Flash Tank	Outside Pit		____	diam (ft)	____	height (ft)	Good
E. Air Pollution Control Systems and Emission Monitoring							
5. Stack	1960	2	2'4"	diam	40	height (ft)	Good
F. Combustion Controls							
3. Flame Safeguard System	1987	2					Good
4. Furnace Draft Control (DAMPACT)	1985	2					Good
5. Additional Boiler Instrumentation/Indicators	1985	2		O2 TRIM			Good

Table 15a (Cont'd)

Equipment	Year Installed	Units	Specification 1		Specification 2		Condition
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	1987	3	50	gal	0.333	Hp	Good
H. Make-up Water System							
9. Sodium Zeolite Softener	1985	1	290	gpm			
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1991	1	33.60	SCFM	(15 Hp)		Good
2. Air Dryer (REFR)	1991	1	40.50	SCFM			
3. Air Receiver	1991	1	50	gal			Good
K. Electrical System							
1. Transformer/TransPCB	____	3	75	KVA			Good
2. Switchgear -- Main Circuit Breaker	1985	1	60	amps			Good
L. Physical Plant							
1. Building Siding, Roofing, Windows, and Doors	1985						Good
2. Building Concrete and Building Steel	1985						Good
3. Sump Pump (SUBMERGE/VERTICAL)	1989	1	____	gpm	(3 Hp)		
4. Building Lighting	1985						Good
Building Outside Dimensions	____	Ht (ft)	____	Lgth (ft)	____	Width (ft)	
Building Basement (Yes/No)	No						
Building Size	1956		2828	sq ft			

Table 15b

Status Quo Life-Cycle Cost Analysis
for Fort Campbell Bldg. 7008

LIFE CYCLE COST ANALYSIS STUDY: TDCAM3
LCCID 1.065 DATE/TIME: 05-14-92 15:47:36
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 7008
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	37058.9	1.58	JUL93-JUL17
NATURAL GAS	364373.4	3.64	JUL93-JUL17
MAINT LABOR	94000.0	.00	JUL93-JUL17
MAINT SERV	16949.0	.00	JUL93-JUL17
MAINT SUPPLY	125424.0	.00	JUL93-JUL17
MAINT UTIL	84746.0	.00	JUL93-JUL17
DRUMCTL	10000.0	.00	JAN 05
ECONOMIZER	35000.0	.00	JAN 05
FTBOILER	1327500.0	.00	JAN 10
FTBURNER	112800.0	.00	JAN 10
RELVALVE	6800.0	.00	JAN 10
PUMPSIMPLEX	9000.0	.00	JAN 07
TANKPOLY	600.0	.00	JAN 07
DAMPACT	2000.0	.00	JAN 15
FLAMESAFE	20000.0	.00	JAN 17
O2TRIM	20000.0	.00	JAN 15
AIRCOMPRECIP	32000.0	.00	JAN 11
AIRDRYERREFR	16000.0	.00	JAN 06
FWPIPINGVAL	1120.0	.00	JAN 05
NAGPIPEBELOW	23.0	.00	JAN 10
OILPIPEBELOW	25.0	.00	JAN 10
PUMP	7400.0	.00	JAN 10
TANKBELOW	42000.0	.00	JAN 15
SZSOFT	191000.0	.00	JAN 05
SUMPPUMPVERT	4900.0	.00	JAN 04

Table 15b (Cont'd)

```
LCCID 1.065                        DATE/TIME:  05-14-92  15:47:36
PROJECT NO., FY, & TITLE:          FY 1992     BUILDING 7008
INSTALLATION & LOCATION: FORT CAMPBELL   KENTUCKY
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:

              BASIC INPUT DATA SUMMARY


               OTHER KEY INPUT DATA

     LOCATION   - KENTUCKY              CENSUS REGION:  3
     RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 91

ENERGY USAGE:  10**6 BTUS       ELECTRIC DEMAND: 10**0 DOLLARS
ENERGY TYPE   $/MBTU    AMOUNT    ELECT. DEMAND  PROJECTED DATES
DIST            4.04    9173.0                     JAN93-JAN18
NAT G           2.99  121864.0                     JAN93-JAN18
```

Table 15b (Cont'd)

```
LCCID  1.065                     DATE/TIME:  05-14-92  15:47:36
PROJECT NO., FY, & TITLE:     FY 1992    BUILDING 7008
INSTALLATION & LOCATION: FORT CAMPBELL    KENTUCKY
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                              0.

ENERGY COSTS:

DISTILLATE OIL                     638201.
NATURAL GAS                       7961011.

TOTAL ENERGY COSTS                              8599212.

RECURRING M&R/CUSTODIAL COSTS                   4677794.

MAJOR REPAIR/REPLACEMENT COSTS                   851324.

OTHER O&M COSTS & MONETARY BENEFITS                   0.

DISPOSAL COSTS/RETENTION VALUE                        0.

LCC OF ALL COSTS/BENEFITS (NET PW)             14128330.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91
```

Table 15b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 15:47:36
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 7008
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	35454.	349791.	304705.	0.	0.
2	33921.	339612.	291305.	0.	0.
3	32352.	325582.	278494.	0.	0.
4	30923.	311264.	266247.	0.	0.
5	29591.	300042.	254538.	0.	0.
6	28466.	291171.	243344.	0.	0.
7	27798.	292937.	232642.	0.	0.
8	27321.	299446.	222412.	0.	0.
9	26928.	308579.	212631.	0.	0.
10	26653.	323166.	203280.	0.	0.
11	26374.	333264.	194340.	0.	0.
12	26058.	336694.	185794.	2900.	0.
13	25725.	343916.	177623.	134143.	0.
14	25265.	347807.	169812.	8653.	0.
15	24711.	349315.	162344.	4964.	0.
16	24048.	345543.	155204.	0.	0.
17	23320.	337082.	148379.	0.	0.
18	22518.	332548.	141854.	657156.	0.
19	21811.	324325.	135615.	13822.	0.
20	21244.	315886.	129651.	0.	0.
21	20713.	307996.	123950.	0.	0.
22	20147.	299577.	118499.	0.	0.
23	19577.	291103.	113287.	23092.	0.
24	18943.	281677.	108305.	0.	0.
25	18339.	272690.	103542.	6596.	0.
***	638201.	7961011.	4677794.	851324.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 16a

Boiler Evaluation Parts List--Fort Campbell Bldg. 7223

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1972	3	10	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			100	psig	333	temp	Good
2. Relief Valve(s)	1972	3	1.5	in.	115	psig	Good
2. Relief Valve(s)	1992	3	1.5	in.	110	psig	Good
3. Feedwater Regulator(s)	1991	3	1	in.	165	psig	Good
4. Boiler Burner(s)	1972	3	12600	MBtu			Good
5. Boiler Fan(s) (FD)	1972	3	5	Hp			Good
6. Boiler Economizer	1972	1	520,475	MBtu	(711927 MBtu/hr)		
7. Boiler Drum Level Control	1991	3					Good
B. Feedwater System							
8. Deaerating Heater	1972	1	19,500	lb/hr			
12. Condensate Pumps	1972	1	1.5	Hp			Good
12. Condensate Pumps	1990	2	1.5	Hp			Good
13. Condensate Receiver	1972	1	500	gal			Good
14. Boiler Feed Pumps	1972	3	10	Hp	(1-turbine,2-motor)		Good
19. Feedwater Piping System (valve)	1972/1991		2	diam (in.)	160	psig	Good
C. Fuel Handling System							
3. Fuel Oil Tank - Underground	1972	1	20000	gal			Good
4. Fuel Oil Pump	1972	6	20	gpm	(1.5 Hp)		
6. Fuel Oil Piping System (BLW)	1972		1.5	diam (in.)	(narrows to 0.5)		Good
7. Natural Gas Piping System (BLW)	1972		4	diam (in.)			Good
D. Heat Recovery System							
1. Blowdown Flash Tank	Outside Pit (~6'x6'x6')						Good
E. Air Pollution Control Systems and Emission Monitoring							
5. Stack	1972	3	20	diam (in.)	32	height (ft)	
F. Combustion Controls							
1. Plant Master	1991	1					Good
2. Boiler Master	1991	3					Good
3. Flame Safeguard System	1985	3					Good
4. Furnace Draft Control (DAMPACT)	1991	3					Good

Table 16a (Cont'd)

Equipment	Year Installed	Units	Specification 1		Specification 2		Condition
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	1972	5	30	gal	0.333	Hp	Good
H. Make-up Water System							
9. Sodium Zeolite Softener	1972	1	58	gpm			Good
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1989	1	250	SCFM	(50 Hp)		Good
1. Air Compressor (RECIP)	1991	1	250	SCFM	(25 Hp)		Good
2. Air Dryer (REFR)	1972	2	250	SCFM			Good
3. Air Receiver	1972	1	100	gal			Good
K. Electrical System							
1. Transformer/TransPCB	___	3	75	KVA			
2. Switchgear -- Main Circuit Breaker	1972	1	600	amps			Good
3. Motor Control Center/Starter	___	___	___	amps			
L. Physical Plant	1972						Good
1. Building Siding, Roofing, Windows, and Doors	1972						Good
2. Building Concrete and Building Steel	1972						Good
4. Building Lighting	1972						Good
Building Outside Dimensions	___	Ht (ft)	___	Lgth (ft)	___	Width (ft)	
Building Basement (Yes/No)	No						
Building Size			2530	sq ft			

Table 16b

Status Quo Life-Cycle Cost Analysis
for Fort Campbell Bldg. 7223

LIFE CYCLE COST ANALYSIS STUDY: TDCAM4
LCCID 1.065 DATE/TIME: 05-14-92 15:50:22
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 7223
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS \$ (\$ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	7526.5	1.58	JUL93-JUL17
NATURAL GAS	73999.5	3.64	JUL93-JUL17
MAINT LABOR	85600.0	.00	JUL93-JUL17
MAINT SERV	4054.0	.00	JUL93-JUL17
MAINT SUPPLY	30000.0	.00	JUL93-JUL17
MAINT UTIL	20270.0	.00	JUL93-JUL17
STACK	12500.0	.00	JAN 12
DRUMCTL	15000.0	.00	JAN 11
ECONOMIZER	35000.0	.00	JAN 92
F_FAN	21000.0	.00	JAN 12
RELVALVE	3096.0	.00	JAN 92
RELVALVE	3072.0	.00	JAN 92
WTBOILER	1800000.0	.00	JAN 12
WTBURNER	150000.0	.00	JAN 12
PUMPSIMPLEX	15000.0	.00	JAN 92
TANKPOLY	1000.0	.00	JAN 92
FLAMESAFE	30000.0	.00	JAN 15
AIRCOMPRECIP	39000.0	.00	JAN 11
AIRCOMPRECIP	48000.0	.00	JAN 09
AIRDRYERREFR	40000.0	.00	JAN 87
AIRRECV	600.0	.00	JAN 02
SWITCH	14667.0	.00	JAN 12
CONDPUMP	3625.0	.00	JAN 92
CONDPUMP	7250.0	.00	JAN 10
CONDREC	14000.0	.00	JAN 02
DAIRHEATER	25000.0	.00	JAN 12
FEEDPUMP	42000.0	.00	JAN 02
FWPIPINGVAL	3339.0	.00	JAN 92
NAGPIPEBELOW	23.0	.00	JAN 97

LCCID 1.065 DATE/TIME: 05-14-92 15:50:22
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 7223
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

OILPIPEBELOW	25.0	.00	JAN 97
PUMP	7800.0	.00	JAN 97
TANKBELOW	26000.0	.00	JAN 02
FLASHTANK	1730.0	.00	JAN 97
SZSOFT	75200.0	.00	JAN 92

OTHER KEY INPUT DATA

LOCATION - KENTUCKY CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	4.04	1863.0		JAN93-JAN18
NAT G	2.99	24749.0		JAN93-JAN18

Table 16b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 15:50:22
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 7223
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
DISTILLATE OIL	129616.	
NATURAL GAS	1616778.	
TOTAL ENERGY COSTS		1746394.
RECURRING M&R/CUSTODIAL COSTS		2038296.
MAJOR REPAIR/REPLACEMENT COSTS		956777.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		4741467.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

LCCID 1.065 DATE/TIME: 05-14-92 15:50:22
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 7223
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	7201.	71038.	132772.	0.	0.
2	6889.	68971.	126933.	0.	0.
3	6571.	66121.	121351.	0.	0.
4	6280.	63214.	116014.	0.	0.
5	6010.	60935.	110912.	7765.	0.
6	5781.	59133.	106034.	0.	0.
7	5646.	59492.	101371.	0.	0.
8	5549.	60814.	96913.	0.	0.
9	5469.	62668.	92651.	0.	0.
10	5413.	65631.	88577.	53478.	0.
11	5356.	67682.	84681.	0.	0.
12	5292.	68378.	80957.	0.	0.
13	5225.	69845.	77397.	0.	0.
14	5131.	70635.	73993.	0.	0.
15	5019.	70941.	70739.	0.	0.
16	4884.	70175.	67629.	0.	0.
17	4736.	68457.	64654.	22684.	0.
18	4573.	67536.	61811.	3276.	0.
19	4430.	65866.	59093.	23324.	0.
20	4315.	64152.	56494.	835427.	0.
21	4207.	62550.	54010.	0.	0.
22	4092.	60840.	51634.	0.	0.
23	3976.	59119.	49364.	10824.	0.
24	3847.	57205.	47193.	0.	0.
25	3725.	55380.	45117.	0.	0.
***	129616.	1616778.	2038296.	956777.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 17a

Boiler Evaluation Parts List—Fort Campbell Bldg. 858

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (FT)	1986	2	11.716	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			100	psig	333	temp	Good
2. Relief Valve(s)	1990	2	2.5	in.	150	psig	Good
2. Relief Valve(s)	1990	2	1.5	in.	150	psig	Good
3. Feedwater Regulator(s)	1986	2	1.5	in.	160	psig	Good
4. Boiler Burner(s)	1986	2	14645	MBtu			Good
5. Boiler Fan(s) (FD)	1986	2	15	Hp			Good
7. Boiler Drum Level Control	1986	2					Good
B. Feedwater System							
8. Deaerating Heater	1986	1	35375	lb/hr			
12. Condensate Pumps	1986	1	3	Hp			Good
14. Boiler Feed Pumps	1986	2	7.5	Hp			Good
15. Make-up Pumps	Base water supply pressure						
19. Feedwater Piping System (valve)	1986		2	diam (in.)	160	psig	Good
21. *HTW Distribution System Pumps*	Base water pressure			Hp			
C. Fuel Handling System							
2. Fuel Oil Tank - Above ground	1986	1	15000	gal			Good
4. Fuel Oil Pump	1986	2	18	gpm	(0.5 Hp)		
6. Fuel Oil Piping System (BLW)	1986		2	diam (in.)	(narrows to 0.5)		Good
7. Natural Gas Piping System (BLW)	1986		4	diam (in.)			Good
D. Heat Recovery System							
1. Blowdown Flash Tank	Outside Pit		______	diam (ft)	______	height (ft)	Good
E. Air Pollution Control Systems and Emission Monitoring							
5. Stack	1942	1	20	diam (in)	24'2"	height (ft)	
F. Combustion Controls							
3. Flame Safeguard System	1986	2					Good
4. Furnace Draft Control (DAMPACT)	1986	2					Good
5. Additional Boiler Instrumentation/Indicators	1986	2		O2 TRIM			Good
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	1986	4	55	gal	0.333	Hp	Good

Table 17a (Cont'd)

Equipment	Year Installed	Units	Specification 1		Specification 2	Condition
H. Make-up Water System						
9. Sodium Zeolite Softener	1991	1	290	gpm		
I. Condensate Polishing						
J. Compressed Air System						
1. Air Compressor (RECIP)	1990	1	3.4	SCFM	(2 Hp)	
3. Air Receiver	1990	1	30	gal		Good
K. Electrical System						
1. Transformer/TransPCB	____	3	25	KVA		
2. Switchgear -- Main Circuit Breaker	1986	1	200	amps		Good
3. Motor Control Center/Starter	____	____	____	amps		
L. Physical Plant						
1. Building Siding, Roofing, Windows, and Doors	1986	____	____			Good
2. Building Concrete and Building Steel	1986	____	____			Good
4. Building Lighting	1986					
Building Outside Dimensions	____	____ Ht (ft)	____	Lgth (ft)	____ Width (ft)	Good
Building Basement (Yes/No)	No					
Building Size			3808	sq ft		

Table 17b

Status Quo Life-Cycle Cost Analysis
for Fort Campbell Bldg. 858

```
      LIFE CYCLE COST ANALYSIS                          STUDY: TDCAMS
LCCID  1.065                  DATE/TIME:  05-14-92  15:53:27
PROJECT NO., FY, & TITLE:      FY 1992    BUILDING 858
INSTALLATION & LOCATION: FORT CAMPBELL     KENTUCKY
DESIGN FEATURE:
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER:
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	13029.0	1.58	JUL93-JUL17
NATURAL GAS	128088.6	3.64	JUL93-JUL17
MAINT LABOR	94000.0	.00	JUL93-JUL17
MAINT SERV	6333.0	.00	JUL93-JUL17
MAINT SUPPLY	46864.0	.00	JUL93-JUL17
MAINT UTIL	31665.0	.00	JUL93-JUL17
DRUMCTL	10000.0	.00	JAN 06
FTBOILER	1200000.0	.00	JAN 11
FTBURNER	100000.0	.00	JAN 11
RELVALVE	3400.0	.00	JAN 10
RELVALVE	4300.0	.00	JAN 10
PUMPSIMPLEX	12000.0	.00	JAN 06
TANKPOLY	800.0	.00	JAN 06
DAMPACT	2000.0	.00	JAN 16
FLAMESAFE	20000.0	.00	JAN 16
O2TRIM	20000.0	.00	JAN 16
AIRCOMPRECIP	20000.0	.00	JAN 10
CONDPUMP	4000.0	.00	JAN 06
FEEDPUMP	28000.0	.00	JAN 16
FWPIPINGVAL	2226.0	.00	JAN 06
NAGPIPEBELOW	23.0	.00	JAN 11
OILPIPEBELOW	25.0	.00	JAN 11
PUMP	2600.0	.00	JAN 11
SZSOFT	135000.0	.00	JAN 11

Table 17b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 15:53:27
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 858
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

OTHER KEY INPUT DATA

LOCATION - KENTUCKY CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	4.04	3225.0		JAN93-JAN18
NAT G	2.99	42839.0		JAN93-JAN18

Table 17b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 15:53:27
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 858
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
DISTILLATE OIL	224376.	
NATURAL GAS	2798544.	
TOTAL ENERGY COSTS		3022920.
RECURRING M&R/CUSTODIAL COSTS		2605513.
MAJOR REPAIR/REPLACEMENT COSTS		673316.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		6301749.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 17b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 15:53:27
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 858
INSTALLATION & LOCATION: FORT CAMPBELL KENTUCKY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	12465.	122963.	169719.	0.	0.
2	11926.	119384.	162255.	0.	0.
3	11374.	114452.	155120.	0.	0.
4	10872.	109419.	148298.	0.	0.
5	10403.	105474.	141777.	0.	0.
6	10008.	102356.	135542.	0.	0.
7	9773.	102976.	129581.	0.	0.
8	9605.	105265.	123882.	0.	0.
9	9467.	108475.	118434.	0.	0.
10	9370.	113603.	113226.	0.	0.
11	9272.	117153.	108247.	0.	0.
12	9161.	118358.	103486.	0.	0.
13	9044.	120897.	98935.	0.	0.
14	8883.	122265.	94584.	15698.	0.
15	8688.	122795.	90425.	0.	0.
16	8455.	121469.	86448.	0.	0.
17	8199.	118495.	82646.	0.	0.
18	7917.	116901.	79012.	12515.	0.
19	7668.	114010.	75537.	620957.	0.
20	7469.	111044.	72215.	0.	0.
21	7282.	108270.	69039.	0.	0.
22	7083.	105311.	66003.	0.	0.
23	6883.	102332.	63101.	0.	0.
24	6660.	99018.	60326.	24146.	0.
25	6447.	95859.	57673.	0.	0.
***	224376.	2798544.	2605513.	673316.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 18

CHPECON Run Results for Fort Campbell, Bldg. 7088

Technology (New Plant)	Boiler	$/MBtu	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
GAS	21/21/21	10.565	12.631	4400	17161	28894	100
#2 OIL	21/21/21	12.216	14.605	4400	21677	33410	116
#6 OIL	21/21/21	12.680	15.161	4400	22947	34680	120
STOKER	15/25/25/25	24.347	29.109	35693	9360	66587	230
CWS	13/25/32/32	20.018	23.933	24269	13190	57211	198
COM	15/26/26/26	20.916	25.007	20867	20198	59778	207
FBC	12/23/29/29	24.023	28.721	33204	10837	65699	227

FILE PREFIX: FCB1
PMCR: 63 L
AVE MON. LOAD: 21 M
CHP #1 2@ 25.1 L
FUEL = NG,FS2
AGE = 1985

1@ 12.5 L
FUEL = NG,FS2
AGE = 1958
L=(K# STEAM/HR)
M=(MBTU/HR)

Table 19

CHPECON Run Results for Fort Campbell, Bldg. 7088

Technology (New Plant)	Boiler	$/MBtu	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
GAS	39/39/39	8.933	10.680	5495	30835	44209	100
#2 OIL	39/39/39	10.584	12.654	5495	39006	52381	118
#6 OIL	39/39/39	11.049	13.210	5495	41305	54679	124
STOKER	26/45/45/45	16.817	20.106	42349	15622	83224	188
CWS	23/45/58/58	14.684	17.556	31094	23159	75940	172
COM	28/47/47/47	15.628	18.685	25296	35545	80823	183
FBC	21/42/53/53	17.108	20.455	39995	19198	84667	192

FILE PREFIX: FCB2
PMCR: 115 L
AVE MON. LOAD: 38 M
CHP #2 1@ 15 L

FUEL = NG,FS2
AGE = 1976
L = (K# STEAM/HR)
M = (MBTU/HR)

Table 20

Cost Sensitivity Analysis for a Gas-/#2 Oil-Fired Boiler Plant

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 1
File: FCB Type: New plant (NP) 04/29/92
Desc: FORT CAMPBELL
Tech: Gas / Oil Fired Boiler

****
Base and Plant Information
****

State: KY - Kentucky Base DOE Region: 3
PMCR: 248,000 lb/hr steam Number of boilers: 3

Height of the plant: 40 ft
Building area: 9000 sq ft
Plant area: 1.97 acres

****
Facility Parameters
****

Capital Equipment Escalation Factor: 1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor: 1.106 (947.10/1991)
Operation & Maintenance Labor Escalation Factor: 1.061 (4386.55/1991)
Construction Labor Escalation Factor: 1.030 (272.70/1991)

Annual electricity usage: 1,107,534 kW-hr

1991 cost for distillate: 0.631 $/gallon
1991 cost for residual: 0.400 $/gallon
1991 cost for natural gas: 2.722 $/million Btu
1991 cost for electricity: 0.053 $/kW-hr

Annual Facility Output: 504,528 thousand lb steam
Annual #6 Fuel Oil Usage: 4,419 10^3 gal
Heating plant efficiency: 87.8% #6 fuel oil
Year of Study: 1991
Years of Operation: 1995 - 2019

****
Facility Capital Costs
****

Equipment		Cost	Equipment		Cost
Boiler:	$	1,659,820	Stack:	$	32,911
Building/service:	$	1,375,970	Water trtmnt:	$	909,326
Feedwtr pmps:	$	30,866	Cond xfr pmps:	$	31,970
Cond strg tnk:	$	8,326	Oil (long) storage:	$	338,767
Oil day strg pmp:	$	5,015	Oil heaters:	$	8,828
Oil day strg tanks:	$	22,024	Oil unload pumps:	$	13,791
Oil xfr pmps:	$	6,425	Fire protection:	$	52,241
Cont bldn tnk:	$	1,170	Intr bldn tnk:	$	1,170
Compressor:	$	24,453	Car puller:	$	20,896
Rail:	$	22,202	Site preparation:	$	5,145
Site improvements:	$	234,040	Mobile equipment:	$	40,748
Elec substation:	$	71,047	Electrical:	$	196,557
Piping:	$	1,113,824	Instrumentation:	$	411,834
Direct costs:	$	2,445,479			

Central Heating Plant Economics Evaluation -- Sensitivity Analysis — Page 2
File: FCB Type: New plant (NP) — 04/29/92
Desc: FORT CAMPBELL
Tech: Gas / Oil Fired Boiler

****

Facility Capital Costs, cont

****

Plant installed cost: $ 10,005,382

****

Facility Annual O & M and Energy Costs

****

Operating staff: 11
Annual Labor Costs: $ 463,732
Annual Year Non-Labor O & M Costs : $ 636,375
1995 #6 fuel oil costs : $ 2,375,110
1995 Auxiliary Energy Costs : $ 58,831

****

Periodic Major Maintenance Cost Summary

****

Time Interval	Cost	Time Interval	Cost
3 years	$ 30,000	5 years	$ 6,545
10 years	$ 380,276	15 years	$ 111,936
18 years	$ 12,788	20 years	$ 14,981

****

Facility Life Cycle Cost Summary

****

Analysis using #6 fuel oil as primary fuel

+ PV 'Adjusted' Investment Costs	= $ 8,717,534
+ PV Energy + Transportation Costs	= $ 46,049,710
+ PV Annually Recurring O&M Costs	= $ 8,038,518
+ PV Non-Annually Recurring Repair & Replacement	= $ 533,848
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 63,339,610

Levelized Cost of Service (1995 start) = 8.6855 $/MMBtu
Levelized Cost of Service (1995 start) = 10.384 $/1000 lb steam

****

Sensitivity Analysis

****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	22,623,314	40,716,296	6.675
60%	27,147,976	45,240,959	7.417

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 3
File: FCB Type: New plant (NP) 04/29/92
Desc: FORT CAMPBELL
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

80%	36,197,302	54,290,285	8.900
90%	40,721,965	58,814,948	9.642
100%	45,246,628	63,339,610	10.384
110%	49,771,290	67,864,273	11.126
120%	54,295,953	72,388,936	11.868
130%	58,820,616	76,913,599	12.609
140%	63,345,279	81,438,262	13.351
150%	67,869,942	85,962,925	14.093

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	32,119,095	50,212,078	8.232
-2%	35,870,371	53,963,354	8.847
-1%	40,211,168	58,304,151	9.558
0%	45,246,628	63,339,610	10.384
1%	51,101,477	69,194,460	11.344
2%	57,923,694	76,016,677	12.462
3%	65,888,844	83,981,826	13.768
4%	75,205,203	93,298,186	15.296
5%	86,119,823	104,212,805	17.085
6%	98,925,680	117,018,663	19.184

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	642,465	63,178,994	10.358
90%	722,773	63,259,302	10.371
100%	803,081	63,339,610	10.384
110%	883,390	63,419,919	10.397
120%	963,698	63,500,227	10.410

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	4,695,839	62,165,650	10.191
90%	5,282,819	62,752,630	10.288
100%	5,869,799	63,339,610	10.384
110%	6,456,779	63,926,590	10.480
120%	7,043,759	64,513,570	10.576

=== O&M non-labor cost variation ===

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	1,734,974	62,905,867	10.313
90%	1,951,846	63,122,739	10.348
100%	2,168,718	63,339,610	10.384
110%	2,385,590	63,556,482	10.419

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 4
File: FCB Type: New plant (NP) 04/29/92
Desc: FORT CAMPBELL
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	427,078	63,232,841	10.366
90%	480,463	63,286,226	10.375
100%	533,848	63,339,610	10.384
110%	587,233	63,392,995	10.393
120%	640,618	63,446,380	10.401

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	6,974,027	61,388,790	10.064
90%	7,845,780	62,364,200	10.224
100%	8,717,534	63,339,610	10.384
110%	9,589,287	64,315,021	10.544
120%	10,461,041	65,290,431	10.704

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-238,027	63,577,638	10.423
-10%	-158,684	63,498,295	10.410
-5%	-79,342	63,418,953	10.397
0%	0	63,339,610	10.384
5%	79,342	63,260,268	10.371
10%	158,684	63,180,926	10.358
15%	238,027	63,101,583	10.345

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	123,547,118	20.255
0.7%	110,712,626	18.151
1.7%	95,258,973	15.617
2.7%	82,563,411	13.536
3.7%	72,068,750	11.815
4.7%	63,339,610	10.384
5.7%	56,034,200	9.186
6.7%	49,882,942	8.178
7.7%	44,672,220	7.323
8.7%	40,231,975	6.595

Table 20 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 5
File: FCB Type: New plant (NP) 04/29/92
Desc: FORT CAMPBELL
Tech: Gas / Oil Fired Boiler

****

Sensitivity Analysis, cont

****

10.7%	33,145,571	5.434
11.7%	30,301,894	4.967
12.0%	29,522,925	4.840

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	34,427,574	10.465
11 yr	36,763,053	10.375
12 yr	39,059,039	10.319
13 yr	41,280,910	10.278
14 yr	43,437,935	10.252
15 yr	45,598,452	10.252
16 yr	47,634,079	10.246
17 yr	49,601,623	10.245
18 yr	51,523,849	10.253
19 yr	53,369,701	10.262
20 yr	55,296,760	10.301
21 yr	57,029,348	10.316
22 yr	58,689,452	10.331
23 yr	60,292,720	10.347
24 yr	61,846,207	10.365
25 yr	63,339,610	10.384

Table 21

Cost Sensitivity Analysis for a #6 Oil-Fired Boiler Plant

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 1
File: FCB6 Type: New plant (NP) 05/04/92
Desc: FORT CAMPBELL
Tech: Gas / Oil Fired Boiler

****
Base and Plant Information
****

State: KY - Kentucky Base DOE Region: 3
PMCR: 188,000 lb/hr steam Number of boilers: 3

Height of the plant: 40 ft
Building area: 7500 sq ft
Plant area: 1.66 acres

****
Facility Parameters
****

Capital Equipment Escalation Factor: 1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor: 1.106 (947.10/1991)
Operation & Maintenance Labor Escalation Factor: 1.061 (4386.55/1991)
Construction Labor Escalation Factor: 1.030 (272.70/1991)

Annual electricity usage: 1,090,986 kW-hr

1991 cost for distillate: 0.631 $/gallon
1991 cost for residual: 0.400 $/gallon
1991 cost for natural gas: 2.722 $/million Btu
1991 cost for electricity: 0.053 $/kW-hr

Annual Facility Output: 504,528 thousand lb steam
Annual #6 Fuel Oil Usage: 4,419 10^3 gal
Heating plant efficiency: 87.8% #6 fuel oil
Year of Study: 1991
Years of Operation: 1995 - 2019

****
Facility Capital Costs
****

Equipment		Cost	Equipment		Cost
Boiler:	$	1,394,832	Stack:	$	32,911
Building/service:	$	1,139,387	Water trtmnt:	$	638,409
Feedwtr pmps:	$	25,260	Cond xfr pmps:	$	25,078
Cond strg tnk:	$	7,177	Oil (long) storage:	$	275,721
Oil day strg pmp:	$	5,015	Oil heaters:	$	7,261
Oil day strg tanks:	$	19,147	Oil unload pumps:	$	13,791
Oil xfr pmps:	$	5,642	Fire protection:	$	41,792
Cont bldn tnk:	$	1,013	Intr bldn tnk:	$	1,013
Compressor:	$	24,453	Car puller:	$	20,896
Rail:	$	11,101	Site preparation:	$	4,336
Site improvements:	$	202,695	Mobile equipment:	$	40,748
Elec substation:	$	65,348	Electrical:	$	165,245
Piping:	$	936,393	Instrumentation:	$	346,229
Direct costs:	$	2,017,766			

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 2
File: FCB6 Type: New plant (NP) 05/04/92
Desc: FORT CAMPBELL
Tech: Gas / Oil Fired Boiler

****
Facility Capital Costs, cont
****

Plant installed cost: $ 8,196,142

****
Facility Annual O & M and Energy Costs
****

Operating staff: 11
Annual Labor Costs: $ 463,732
Annual Year Non-Labor O & M Costs : $ 629,310
1995 #6 fuel oil costs : $ 2,375,137
1995 Auxiliary Energy Costs : $ 57,952

****
Periodic Major Maintenance Cost Summary
****

Time Interval	Cost	Time Interval	Cost
3 years	$ 30,000	5 years	$ 6,310
10 years	$ 260,368	15 years	$ 93,794
18 years	$ 10,031	20 years	$ 13,867

****
Facility Life Cycle Cost Summary
****

Analysis using #6 fuel oil as primary fuel

+ PV 'Adjusted' Investment Costs	= $ 7,182,251
+ PV Energy + Transportation Costs	= $ 47,378,979
+ PV Annually Recurring O&M Costs	= $ 8,161,860
+ PV Non-Annually Recurring Repair & Replacement	= $ 429,474
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 63,152,565

Levelized Cost of Service (1995 start) = 8.4196 $/MMBtu
Levelized Cost of Service (1995 start) = 10.066 $/1000 lb steam

****
Sensitivity Analysis
****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	23,283,222	39,869,342	6.355
60%	27,939,866	44,525,987	7.097

Table 21 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 3
File: FCB6   Type: New plant (NP)   05/04/92
Desc: FORT CAMPBELL
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

80%	37,253,155	53,839,276	8.582
90%	41,909,799	58,495,920	9.324
100%	46,566,444	63,152,565	10.066
110%	51,223,088	67,809,209	10.808
120%	55,879,733	72,465,853	11.551
130%	60,536,377	77,122,498	12.293
140%	65,193,021	81,779,142	13.035
150%	69,849,666	86,435,787	13.777

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	32,964,116	49,550,236	7.898
-2%	36,847,862	53,433,983	8.517
-1%	41,345,360	57,931,480	9.234
0%	46,566,444	63,152,565	10.066
1%	52,641,459	69,227,579	11.034
2%	59,725,098	76,311,219	12.164
3%	68,000,951	84,587,072	13.483
4%	77,686,882	94,273,003	15.027
5%	89,041,388	105,627,509	16.837
6%	102,371,106	118,957,227	18.961

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	650,028	62,990,057	10.040
90%	731,281	63,071,311	10.053
100%	812,535	63,152,565	10.066
110%	893,788	63,233,818	10.079
120%	975,042	63,315,072	10.092

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	4,820,558	61,947,425	9.874
90%	5,423,128	62,549,995	9.970
100%	6,025,698	63,152,565	10.066
110%	6,628,268	63,755,134	10.162
120%	7,230,838	64,357,704	10.258

=== O&M non-labor cost variation ===

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	1,708,929	62,725,332	9.998
90%	1,922,545	62,938,948	10.032
100%	2,136,161	63,152,565	10.066
110%	2,349,777	63,366,181	10.100

Table 21 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 4
File: FCB6   Type: New plant (NP)   05/04/92
Desc: FORT CAMPBELL
Tech: Gas / Oil Fired Boiler

****

Sensitivity Analysis, cont

****

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	343,579	63,066,670	10.052
90%	386,526	63,109,617	10.059
100%	429,474	63,152,565	10.066
110%	472,421	63,195,512	10.073
120%	515,368	63,238,459	10.080

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	5,745,801	61,536,946	9.809
90%	6,464,026	62,344,755	9.937
100%	7,182,251	63,152,565	10.066
110%	7,900,476	63,960,374	10.195
120%	8,618,701	64,768,183	10.324

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-206,154	63,358,719	10.099
-10%	-137,436	63,290,001	10.088
-5%	-68,718	63,221,283	10.077
0%	0	63,152,565	10.066
5%	68,718	63,083,846	10.055
10%	137,436	63,015,128	10.044
15%	206,154	62,946,410	10.033

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	121,276,910	19.331
0.5%	111,988,476	17.851
1.5%	96,020,352	15.305
2.5%	82,925,881	13.218
3.5%	72,121,733	11.496
4.5%	63,152,565	10.066
5.5%	55,661,275	8.872
6.5%	49,366,496	7.869
7.5%	44,045,501	7.020
8.5%	39,521,155	6.299

Table 21 (Cont'd)

Sensitivity Analysis, cont

10.5%	32,324,231	5.152
11.5%	29,446,442	4.693
12.0%	28,152,497	4.487

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	33,190,969	9.914
11 yr	35,585,495	9.861
12 yr	37,944,153	9.835
13 yr	40,231,088	9.820
14 yr	42,455,587	9.816
15 yr	44,679,810	9.833
16 yr	46,787,281	9.844
17 yr	48,828,203	9.858
18 yr	50,824,912	9.879
19 yr	52,747,026	9.900
20 yr	54,713,756	9.941
21 yr	56,524,919	9.966
22 yr	58,263,642	9.990
23 yr	59,946,079	10.015
24 yr	61,579,432	10.041
25 yr	63,152,565	10.066

Table 22

**Cost Sensitivity Analysis for
a Coal-Fired Stoker Plant**

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 1
File: FCBC Type: New plant (NP) 05/04/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

Base and Plant Information

State: KY - Kentucky Base DOE Region: 3
PMCR: 188,000 lb/hr steam Number of boilers: 4

Coal code: W193122 Distance from base: 140 miles
State: IN - Indiana DOE Region: 2
Coal type: bituminous (properties on a dry basis)
hhv: 12830 Btu/lb fixed carbon: 52.10% volatiles: 37.60%
ash: 10.30% sulfur: 2.80%

Coal handling equipment capacity: 100 tons/hr
Coal silo storage capacity: 713 tons
Approx. building width: 66 feet
Approx. building length: 185 feet
Height of the plant: 69 ft
Building area: 12267 sq ft
Plant area: 1.73 acres

Facility Parameters

Capital Equipment Escalation Factor: 1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor: 1.106 (947.10/1991)
Operation & Maintenance Labor Escalation Factor: 1.061 (4386.55/1991)
Construction Labor Escalation Factor: 1.030 (272.70/1991)

Annual diesel/distillate fuel usage: 16,752 gallons
Annual electricity usage: 3,722,308 kW-hr
Annual lime usage: 2,878 tons

1991 cost for coal: 1.534 $/MMBtu
1991 cost for distillate: 0.631 $/gallon
1991 cost for electricity: 0.053 $/kW-hr

Annual Facility Output: 504,528 thousand lb steam
Annual Coal Usage: 26,568 tons (dry) / 28,853 tons (wet)
Heating plant efficiency: 84%
Year of Study: 1991
Years of Operation: 1995 - 2019

Facility Installed Capital Costs

Equipment		Cost	Equipment		Cost
Boiler:	$	12,453,778	Coal Handling:	$	5,835,423
Ash Handling:	$	3,104,084	Mechncl Collector:	$	165,316

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 2
File: FCBC Type: New plant (NP) 05/04/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Facility Installed Capital Costs, cont
****

Water Treatment:	$	1,094,858	Pumps:	$	243,908
Air Compressor:	$	87,327	Waste Water Trtmnt:	$	126,806
Piping/Stack:	$	4,581,222	Electrical System:	$	1,775,832
Building Costs:	$	6,232,328	Direct costs:	$	13,645,671

****

Plant installed cost: $ 58,804,507

****
Facility Annual O & M and Energy Costs
****

Operating staff: 27
Annual Labor Costs: $ 1,123,756

First Year Non-Labor O & M Costs	: $	1,880,194
Annual Year Non-Labor O & M Costs	: $	2,252,342
1995 Coal Costs (incl transport)	: $	1,253,165
1995 Auxiliary Energy Costs	: $	210,604

****
Periodic Major Maintenance Cost Summary
****

Time Interval		Cost	Time Interval		Cost
3 years	$	110,659	5 years	$	102,452
7 years	$	110,032	8 years	$	293,999
10 years	$	703,809	12 years	$	56,841
15 years	$	13,894	18 years	$	20,058
20 years	$	710,697			

****
Facility Life Cycle Cost Summary
****

+ PV 'Adjusted' Investment Costs	= $	51,530,190
+ PV Energy + Transportation Costs	= $	21,016,342
+ PV Annually Recurring O&M Costs	= $	28,954,663
+ PV Non-Annually Recurring Repair & Replacement	= $	2,222,765
+ PV Disposal Cost of Existing System	= $	0
+ PV Disposal Cost of New/Retrofit Facility	= $	0
Total Life Cycle Cost (1991)	= $	103,723,962

Levelized Cost of Service (1995 start) = 13.828 $/MMBtu

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 3
File: FCBC Type: New plant (NP) 05/04/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****

Sensitivity Analysis

****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	9,009,308	94,714,654	15.097
60%	10,811,170	96,516,515	15.384
70%	12,613,032	98,318,377	15.672
80%	14,414,893	100,120,239	15.959
90%	16,216,755	101,922,100	16.246
100%	18,018,617	103,723,962	16.533
110%	19,820,478	105,525,824	16.820
120%	21,622,340	107,327,686	17.108
130%	23,424,202	109,129,547	17.395
140%	25,226,064	110,931,409	17.682
150%	27,027,925	112,733,271	17.969

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	13,062,520	98,767,866	15.743
-2%	14,483,961	100,189,307	15.970
-1%	16,123,144	101,828,489	16.231
0%	18,018,617	103,723,962	16.533
1%	20,216,101	105,921,446	16.883
2%	22,769,827	108,475,172	17.291
3%	25,744,126	111,449,471	17.765
4%	29,215,305	114,920,651	18.318
5%	33,273,870	118,979,216	18.965
6%	38,027,145	123,732,490	19.723

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	2,398,180	103,124,417	16.438
90%	2,697,952	103,424,190	16.485
100%	2,997,725	103,723,962	16.533
110%	3,297,498	104,023,735	16.581
120%	3,597,270	104,323,507	16.629

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	11,681,587	100,803,565	16.068
90%	13,141,786	102,263,764	16.300
100%	14,601,984	103,723,962	16.533
110%	16,062,183	105,184,161	16.766
120%	17,522,381	106,644,359	16.999

=== O&M non-labor cost variation ===

Table 22 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 4
File: FCBC Type: New plant (NP) 05/04/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Sensitivity Analysis, cont
****

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	11,482,143	100,853,426	16.076
90%	12,917,411	102,288,694	16.304
100%	14,352,679	103,723,962	16.533
110%	15,787,947	105,159,230	16.762
120%	17,223,214	106,594,498	16.991

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	1,7[illegible]8,212	103,279,409	16.462
90%	2,000,488	103,501,686	16.498
100%	2,222,765	103,723,962	16.533
110%	2,445,042	103,946,239	16.569
120%	2,667,318	104,168,515	16.604

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	41,224,152	91,470,671	14.580
90%	46,377,171	97,597,317	15.557
100%	51,530,190	103,723,962	16.533
110%	56,683,209	109,850,608	17.510
120%	61,836,228	115,977,253	18.486

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-1,394,131	105,118,093	16.755
-10%	-929,420	104,653,383	16.681
-5%	-464,710	104,188,673	16.607
0%	0	103,723,962	16.533
5%	464,710	103,259,252	16.459
10%	929,420	102,794,542	16.385
15%	1,394,131	102,329,831	16.311

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	161,034,128	25.669
0.5%	152,193,988	24.259
1.5%	136,779,317	21.802

Table 22 (Cont'd)

File: FCBC Type: New plant (NP) 05/04/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Sensitivity Analysis, cont
****

3.5%	112,985,027	18.009
4.5%	103,723,962	16.533
5.5%	95,786,505	15.268
6.5%	88,931,588	14.175
7.5%	82,967,545	13.225
8.5%	77,741,219	12.392
9.5%	73,129,595	11.656
10.5%	69,033,368	11.003
11.5%	65,371,960	10.420
12.0%	63,683,284	10.151

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	78,391,926	23.416
11 yr	80,478,563	22.303
12 yr	82,571,218	21.403
13 yr	84,500,351	20.626
14 yr	86,405,609	19.977
15 yr	88,286,870	19.430
16 yr	90,124,913	18.962
17 yr	91,770,364	18.528
18 yr	93,405,064	18.155
19 yr	94,927,739	17.816
20 yr	96,943,797	17.615
21 yr	98,429,824	17.355
22 yr	99,785,712	17.110
23 yr	101,090,300	16.888
24 yr	102,486,189	16.711
25 yr	103,723,962	16.533

Table 23

Fort Bragg Heating Plant Information

Plant	Boiler	Fuel	Reserve	Year Installed	Capacity (lb/hr)	In use	Rating	Energy Use Heat/Cool/ Process/Losses/ Internal/Pwr Gen
4-3124	1	Nat. Gas	FS6	1972	37850	Y	8	H
4-3124	2	Nat. Gas	FS6	1972	37850	Y	8	H
4-3124	3	Nat. Gas	FS6	1952	50000	Y	6	H
C-1432	1	Nat. Gas	FS6	1953	100000	Y	8	H
C-1432	2	Nat. Gas	FS6	1953	100000	Y	7	H
C-1432	3	Nat. Gas	FS6	1953	100000	Y	7	H
C-7549	1	Nat. Gas	FS2	1973	50000	NO	5	H
C-7549	2	Nat. Gas	FS2	1973	50000	NO	5	H
D-3529	1	Nat. Gas	FS6	1965	26000	Y	4	H/C 60/40
D-3529	2	Nat. Gas	FS6	1965	26000	Y	4	H/C 60/40
D-3529	3	Nat. Gas	FS6	1965	26000	Y	6	H/C 60/40
D-3529	4	Nat. Gas	FS6	1969	26000	Y	8	H/C 60/40
D-3529	5	Nat. Gas	FS6	1978	26000	Y	8	H/C 60/40
E-2823	1	Nat. Gas	FS2	1988	20000	Y	9	H/C 60/40
E-2823	2	Nat. Gas	FS2	1988	20000	Y	9	H/C 60/40
N-6002	1	Nat. Gas	FS6	1985	25000	Y	9	?
N-6002	2	Nat. Gas	FS6	1985	25000	Y	9	?

Table 24

Fort Bragg Energy Use Data

Fuel	Units	Btu/Unit	$/Unit	1989 Use	1990 Use	$/MBtu	MBtu '90	MBtu '89
Dist. oil	gal	138700	1.03	4309368	3667440	7.43	508674	597709
Res. oil	gal	149700	0.99	708876	1005564	6.61	150533	106119
Nat. gas	Total NAG use:			1142170	943459		972706	1177577
Interr.	kscf	1031000	4.64			4.50		
Unintr.	kscf	1031000	4.04			3.92		
Building:		D-3529	E-2823	C-1432	N-6002	4-3124		
Capacity (lb/hr):		130000	40000	300000	50000	113700		
SQ file:		BRG1	BRG2	BRG3	BRG4	(closing)		
Annual Costs								
Labor		207900	134400	323400	134400	122500		
Utilities*		175676	54054	405405	67568	54054		
Service*		35135	10811	81081	13514	10811		
Supplies*		248000	80000	500000	100000	80000		
Average steam production, 1990 (lb/hr):								
October		22129.8	5572.0	57170.0	5427.0	12243.1		
November		29118.1	7105.0	61100.0	8100.0	13617.8		
December		41597.3	11457.5	79020.0	15013.0	11684.7		
January		32113.1	10964.0	87280.0	13200.0	16265.0		
February		34026.6	7362.5	72170.0	7508.0	16447.0		
March		33111.5	6679.0	71810.0	6177.0	15064.0		
April		28119.8	7656.0	69150.0	8397.0	13175.0		
May		29534.1	6636.5	59400.0	7333.0	11158.0		
June		29534.1	5389.0	44750.0	6303.0	10300.0		
July		34276.2	4610.0	40300.0	5190.0	9442.0		
August		31198.0	4333.0	38830.0	4783.0	10729.0		
September		30782.0	4596.5	41920.0	5001.0	9013.0		
Fuel energy, based on steam production, 1990 (MBTu):								
October		19836.8	4994.7	51246.4	4864.7	10974.5		
November		25259.1	6163.4	53002.4	7026.5	11813.0		
December		37287.3	10270.3	70832.4	13457.4	10474.0		
January		28785.8	9828.0	78236.5	11832.3	14579.7		
February		27549.3	5961.0	58431.6	6078.8	13316.1		
March		29680.7	5987.0	64369.4	5537.0	13503.2		

* = estimated

Table 24 (Cont'd)

Fuel	Units	Btu/Unit	$/Unit	1989 Use	1990 Use	$/MBtu	MBtu '90	MBtu '89
Fuel energy, based on steam production, 1990 (MBtu) (cont'd):								
April		24393.1	6641.3	59985.5	7284.1	11428.9		
May		26473.9	5948.9	53245.3	6573.1	10001.9		
June		25620.1	4674.8	38819.3	5467.7	8934.9		
July		30724.9	4132.3	36124.3	4652.2	8463.7		
August		27965.4	3884.0	34806.7	4287.4	9617.3		
September		26702.5	3987.3	36364.3	4338.2	7818.5		
Total		330278.5	72473.0	635464.2	81399.5	130925.8	1250541	
Percent of total		26.4	5.8	50.8	6.5	10.5		
Reserve fuel		#6	#2	#6	#6	#6		
Fuel use (MBtu/year):							Total	
Natural Gas		307159.0	67399.9	590981.7	75701.6	121761.0	1163003	
Dist. Oil		0.0	5073.1	0.0	0.0	0.0	5073	
Res. Oil		23119.5	0.0	44482.5	5698.0	9164.8	82465	
Total $/yr:		2803775	752324.4	5421652	842176	11145196		
$/MBtu:								
Labor		0.63	1.85	0.51	1.65	0.94		
Utilities		0.53	0.75	0.64	0.83	0.41		
Service		0.11	0.15	0.13	0.17	0.08		
Supplies		0.75	1.10	0.79	1.23	0.61		
Fuel		5.43	5.43	5.43	5.43	5.43	Average	
Total $/MBtu		7.45	9.29	7.50	9.31	7.48	8.20	

* = estimated

Table 25a

Boiler Evaluation Parts List—Fort Bragg Bldg. 1432

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. **Boiler** (WT)	1958	3	100	MBtu/hr			Fair
1. Boiler Pressure Parts and Setting			150	psig	400	temp	Fair
2. Relief Valve(s)	1958	6	6	in.	180	psig	Fair
3. Feedwater Regulator(s)	1958	3	3	in.	350	psig	Fair
4. Boiler Burner(s)	1975	3	______	MBtu			Fair
5. Boiler Fan(s) (FD)	1958	3	40	Hp			Fair
5. Boiler Fan(s) (ID)	1958	3	125	Hp			Fair
6. Boiler Economizer	Not in Service		______	MBtu			
7. Boiler Drum Level Control	1958	3					Fair
B. **Feedwater System**							
8. Deaerating Heater	1958	1	165	lb/hr			Fair
9. Feedwater Heater	1958	1	200	gpm			Fair
10. Treated Water Storage	1958	1	20000	gal			Fair
11. Treated Water Storage Pumps	1958	1	25	Hp			Fair
12. Condensate Pumps	1958	3	10	Hp			Fair
13. Condensate Receiver	1958	1	500	gal			Fair
14. Boiler Feed Pumps	1991	3	60	Hp			Fair
19. Feedwater Piping System (valve)	____		6	diam (in.)	______	psig	
C. **Fuel Handling System**	Burning Waste Oil						
1. Fuel Oil Unloading Pump	1975	4	10	Hp			Good
2. Fuel Oil Tank - Above ground	1975	1	500000	gal			Good
3. Fuel Oil Tank - Above ground	1975	1	200000	gal			Good
4. Fuel Oil Pump	1991	1	______	gpm	(110 lb oil at 220 F)		
5. Fuel Oil Heater	1991	1	______	gpm			
6. Fuel Oil Piping System (ABV)	1975		1.25	diam (in.)			Good
7. Natural Gas Piping System (BLW)	1975		4	diam (in.)			Good
D. **Heat Recovery System**							
1. Blowdown Flash Tank	1958	1	2.5	diam (ft)	5	height (ft)	Good
2. Blowdown Heat Exchanger	1958	1	20	gpm			Good
E. **Air Pollution Control Systems and Emission Monitoring**							
5. Stack	1975	3	4.333	diam (ft)	65	height (ft)	Good

Table 25a (Cont'd)

Equipment	Year Installed	Units	Specification 1	Specification 2	Condition
F. Combustion Controls					
1. Plant Master	1958	3			Good
2. Boiler Master	1991	3			Good
3. Flame Safeguard System	1991	3			Good
4. Furnace Draft Control (DAMPACT)	1990	3			Good
G. Chemical Feed System					
1. Chemical Storage Tanks and Pumps	1975	2	50 gal	0.5 Hp	Good
H. Make-up Water System					
9. Sodium Zeolite Softener	1975	2	60 gpm		Good
I. Condensate Polishing					
J. Compressed Air System					
1. Air Compressor (RECIP)	1975	3	SCFM	(15 Hp)	Good
2. Air Dryer (REFR)	1975	1	10 SCFM		Good
3. Air Receiver	1975	1	100 gal		Good
K. Electrical System					
1. Transformer/TransPCB	____	____	____ KVA	(175 kW)	Good
2. Switchgear -- Main Circuit Breaker	1958	1	1200 amps		Good
3. Motor Control Center/Starter	1958	1	600 amps		Good
4. Emergency Generator	1958	1	219 KVA		
L. Physical Plant					
1. Building Siding, Roofing, Windows, and Doors	1958	____	____		Good
2. Building Concrete and Building Steel	1958	____	____		Good
3. Sump Pump (SUBMERGE/VERTICAL)	1975	3	gpm	(3 Hp)	Good
4. Building Lighting	1958	____	____		Good
Building Outside Dimensions	____	Ht (ft)	____ Length (ft)	____ Width (ft)	
Building Basement (Yes/No)	____				

Table 25b

Status Quo Life Cycle Cost Analysis
for Fort Bragg Bldg C-1432

```
     LIFE CYCLE COST ANALYSIS                      STUDY: TDBRG3
LCCID  1.065                   DATE/TIME:  05-15-92  09:46:58
PROJECT NO., FY, & TITLE:      FY 1992     BUILDING C-1432
INSTALLATION & LOCATION: FORT BRAGG    NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:

            BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

              DISCOUNT RATE:  4.6%

        KEY PROJECT-CALENDAR INFORMATION

        DATE OF STUDY (DOS)                      MAY 92
        MIDPOINT OF CONSTRUCTION (MPC)           JUN 92
        BENEFICIAL OCCUPANCY DATE (BOD)          JAN 93
        ANALYSIS END DATE (AED)                  JAN 18
```

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
RESIDUAL OIL	294032.6	2.11	JUL93-JUL17
NATURAL GAS	2659419.0	3.64	JUL93-JUL17
MAINT LABOR	323400.0	.00	JUL93-JUL17
MAINT SERV	81081.0	.00	JUL93-JUL17
MAINT SUPPLY	500000.0	.00	JUL93-JUL17
MAINT UTIL	405405.0	.00	JUL93-JUL17
STACK	20000.0	.00	JAN 15
DRUMCTL	15000.0	.00	JAN 98
ECONOMIZER	345000.0	.00	JAN 98
FW_REG	4251.0	.00	JAN 98
F_FAN	50250.0	.00	JAN 98
I_FAN	105000.0	.00	JAN 98
RELVALVE	11910.0	.00	JAN 98
WTBOILER	4500000.0	.00	JAN 98
WTBURNER	350001.0	.00	JAN 15
PUMPSIMPLEX	6000.0	.00	JAN 95
TANKPOLY	400.0	.00	JAN 95
PLANTMASTER	15000.0	.00	JAN 98
AIRCOMPRECIP	60000.0	.00	JAN 95
AIRDRYERREFR	12000.0	.00	JAN 95
AIRRECV	600.0	.00	JAN 05
EMERGENCYGEN	158454.0	.00	JAN 98
MOTORCTRL	3400.0	.00	JAN 98
SWITCH	21000.0	.00	JAN 98
CONDPUMP	16500.0	.00	JAN 98
CONDREC	14000.0	.00	JAN 98
DAIRHEATER	25000.0	.00	JAN 98
FWHEATER	30000.0	.00	JAN 98
FWPIPINGVAL	1400.0	.00	JAN 98

LCCID 1.065 DATE/TIME: 05-15-92 09:46:58
PROJECT NO., FY, & TITLE: FY 1992 BUILDING C-1432
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

TREATPUMP	7000.0	.00	JAN 98
WATERSTOR	38000.0	.00	JAN 98
NAGPIPEBELOW	23.0	.00	JAN 00
PUMP	2500.0	.00	JAN 16
TANKABOVE	120000.0	.00	JAN 15
TANKABOVE	210000.0	.00	JAN 15
UNLOADPUMP	20000.0	.00	JAN 95
FLASHTANK	1200.0	.00	JAN 98
HEATEXCH	1600.0	.00	JAN 98
SZSOFT	153000.0	.00	JAN 95
SUMPPUMPVERT	14700.0	.00	JAN 00

OTHER KEY INPUT DATA

LOCATION - NORTH CAROLINA CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
RESID	6.61	44483.0		JAN93-JAN18
NAT G	4.50	590982.0		JAN93-JAN18

Table 25b (Cont'd)

```
LCCID 1.065                  DATE/TIME:  05-15-92  09:46:58
PROJECT NO., FY, & TITLE:     FY 1992     BUILDING C-1432
INSTALLATION & LOCATION: FORT BRAGG    NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                                 0.

ENERGY COSTS:

RESIDUAL OIL                          5453950.
NATURAL GAS                          58104310.

TOTAL ENERGY COSTS                                63558260.

RECURRING M&R/CUSTODIAL COSTS                     19081330.

MAJOR REPAIR/REPLACEMENT COSTS                     4644441.

OTHER O&M COSTS & MONETARY BENEFITS                      0.

DISPOSAL COSTS/RETENTION VALUE                           0.

LCC OF ALL COSTS/BENEFITS (NET PW)                87284020.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91
```

Table 25b (Cont'd)

LCCID 1.065 DATE/TIME: 05-15-92 09:46:58
PROJECT NO., FY, & TITLE: FY 1992 BUILDING C-1432
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	RESID	NAT G	M & R	R / R	OTHER
1	289339.	2552991.	1242930.	0.	0.
2	282634.	2478697.	1188269.	0.	0.
3	274722.	2376293.	1136013.	222988.	0.
4	263291.	2271791.	1086054.	0.	0.
5	251094.	2189888.	1038293.	0.	0.
6	241110.	2125145.	992632.	4157252.	0.
7	235905.	2138032.	948979.	0.	0.
8	232672.	2185542.	907245.	10429.	0.
9	230105.	2252200.	867347.	0.	0.
10	228518.	2358659.	829204.	0.	0.
11	226912.	2432362.	792738.	0.	0.
12	224740.	2457396.	757876.	0.	0.
13	222426.	2510106.	724547.	339.	0.
14	218751.	2538505.	692683.	0.	0.
15	213961.	2549517.	662221.	0.	0.
16	207937.	2521985.	633098.	0.	0.
17	201161.	2460229.	605257.	0.	0.
18	194225.	2427141.	578639.	0.	0.
19	188164.	2367120.	553192.	0.	0.
20	183268.	2305527.	528865.	0.	0.
21	178690.	2247943.	505607.	0.	0.
22	173806.	2186493.	483372.	0.	0.
23	168890.	2124649.	462114.	252569.	0.
24	163421.	2055847.	441792.	862.	0.
25	158207.	1990255.	422363.	0.	0.
***	5453950.	********	********	4644441.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 26a

Boiler Evaluation Parts List--Fort Bragg Bldg. D-3529

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1965	3	26	MBtu/hr			2 Fair, 1 Good
A. Boiler (WT)	1969	1	26	MBtu/hr			Good
A. Boiler (WT)	1970	1	26	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			240	psig	400	temp	Good
2. Relief Valve(s)	65,69,70	5	2	in.	375	psig	Good
2. Relief Valve(s)	65,69,70	5	2	in.	385	psig	Good
3. Feedwater Regulator(s)	____		____	in.	____	psig	
4. Boiler Burner(s)	65,69,70	5	26	MBtu			Good
5. Boiler Fan(s) (FD)	65,69,70	5	10	Hp			Good
7. Boiler Drum Level Control	Visual						
B. Feedwater System							
8. Deaerating Heater	1965	1	10000	lb/hr			Good
15. Make-up Pumps	1972	1	7.5	Hp			Good
15. Make-up Pumps	1990	1	7.5	Hp			Good
18. Expansion Tank	1965	1	70	diam (in.)	27	length (ft)	Good
19. Feedwater Piping System (valve)	1965		2	diam (in.)	232	psig	Good
20. Cooling Water Pumps	1965	1	300	Hp			Fair
20. Cooling Water Pumps	1969	1	150	Hp			Fair
21. HTW Distribution System Pumps	1965	2	30	Hp			Good
21. HTW Distribution System Pumps	1965	2	50	Hp			Good
21. HTW Distribution System Pumps	1969	2	75	Hp			Good
21. HTW Distribution System Pumps	1970	1	100	Hp			Good
21. HTW Distribution System Pumps	1991	1	40	Hp			Good
C. Fuel Handling System							
2. Fuel Oil Tank - Above ground	1965	2	50000	gal			Good
3. Fuel Oil Tank - Above ground	1970	4	50000	gal			Good
4. Fuel Oil Pump	1965	2	15	gpm			Good
5. Fuel Oil Heater	1965	2	100	gpm			Good
6. Fuel Oil Piping System (BLW)	1965		5	diam (in.)			Good
7. Natural Gas Piping System (BLW)	1965		5	diam (in.)			Good
D. Heat Recovery System							
E. Air Pollution Control Systems and Emission Monitoring							
5. Stack	____	____	____	diam (ft)	____	height (ft)	

Table 26a (Cont'd)

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
F. Combustion Controls							
1. Plant Master	1965	1					Good
2. Boiler Master	65,69,70	5					Good
3. Flame Safeguard System	65,69,70	5					Good
5. Additional Boiler Instrumentation/Indicators	1965			O2 TRIM, FLOWMETER, TEMPREC (O2 trim inoperable)			Recorders Poor
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	___	___	___	gal	___	Hp	
H. Make-up Water System							
9. Sodium Zeolite Softener	1965	2	31	gpm			Good
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1965	1	100	SCFM	(10 Hp)		Good
1. Air Compressor (RECIP)	1991	1	100	SCFM	(10 Hp)		Good
2. Air Dryer (REFR)	1982	1	200	SCFM			Good
3. Air Receiver	1965	1	80	gal			Good
Soot blower Compressor	1965	1	25	gal			Fair
Soot blower Receiver	1965	1	80	gal	(4'x8')		Good
K. Electrical System							
1. Transformer/TransPCB	___	___	___	KVA			
2. Switchgear -- Main Circuit Breaker	___	___	___	amps			
4. Emergency Generator	1965	1	75	KVA			Good
L. Physical Plant							
1. Building Siding, Roofing, Windows, and Doors	1965	___	___				Good
2. Building Concrete and Building Steel	1965	___	___				Good
3. Sump Pump (SUBMERGE/VERTICAL)	1985	2	___	gpm	(2 Hp)		
4. Building Lighting	1965	___	___				Good
Steam generator for atomizer	1965	1	80-110	psi	3800	lb/hr	Good
Building Outside Dimensions	___	Ht (ft)	___	Length (ft)	___	Width (ft)	
Building Basement (Yes/No)	___						

Table 26b

Status Quo Life Cycle Cost Analysis
for Fort Bragg Bldg D-3528

```
     LIFE CYCLE COST ANALYSIS                          STUDY: TDBRG1
LCCID  1.065                     DATE/TIME:  05-14-92  16:46:47
PROJECT NO., FY, & TITLE:        FY 1992     BUILDING D-3529
INSTALLATION & LOCATION: FORT BRAGG     NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER:
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JAN 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
RESIDUAL OIL	152823.2	2.21	JUL93-JUL17
NATURAL GAS	1382216.0	3.39	JUL93-JUL17
MAINT LABOR	207900.0	.00	JUL93-JUL17
MAINT SERV	35135.0	.00	JUL93-JUL17
MAINT SUPPLY	248000.0	.00	JUL93-JUL17
MAINT UTIL	175676.0	.00	JUL93-JUL17
STACK	45000.0	.00	JAN 05
DRUMCTL	5000.0	.00	JAN 90
F_FAN	21000.0	.00	JAN 05
F_FAN	7000.0	.00	JAN 09
F_FAN	7000.0	.00	JAN 10
RELVALVE	7875.0	.00	JAN 85
RELVALVE	2625.0	.00	JAN 89
RELVALVE	2625.0	.00	JAN 90
RELVALVE	7884.0	.00	JAN 85
RELVALVE	2628.0	.00	JAN 89
RELVALVE	2628.0	.00	JAN 90
WTBOILER	2025000.0	.00	JAN 05
WTBOILER	675000.0	.00	JAN 09
WTBOILER	675000.0	.00	JAN 10
WTBURNER	153000.0	.00	JAN 05
WTBURNER	51000.0	.00	JAN 09
WTBURNER	51000.0	.00	JAN 10
BOILMASTER	15000.0	.00	JAN 95
BOILMASTER	5000.0	.00	JAN 99
BOILMASTER	5000.0	.00	JAN 00
FLAMESAFE	30000.0	.00	JAN 95
FLAMESAFE	10000.0	.00	JAN 99
FLAMESAFE	10000.0	.00	JAN 00

Table 26b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:46:47
PROJECT NO., FY, & TITLE: FY 1992 BUILDING D-3529
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

PLANTMASTER	5000.0	.00	JAN 95
AIRCOMPRECIP	20000.0	.00	JAN 85
AIRCOMPRECIP	26000.0	.00	JAN 85
AIRCOMPRECIP	26000.0	.00	JAN 11
AIRDRYERREFR	18000.0	.00	JAN 97
AIRRECV	600.0	.00	JAN 95
AIRRECV	600.0	.00	JAN 95
EMERGENCYGEN	35000.0	.00	JAN 95
DAIRHEATER	25000.0	.00	JAN 05
EXPTANK	27433.0	.00	JAN 05
FWPIPINGVAL	1209.0	.00	JAN 85
HTWPUMP	38000.0	.00	JAN 95
HTWPUMP	38000.0	.00	JAN 95
HTWPUMP	46000.0	.00	JAN 99
HTWPUMP	24000.0	.00	JAN 00
MUPUMP	5000.0	.00	JAN 92
MUPUMP	5000.0	.00	JAN 10
HEATER	16000.0	.00	JAN 95
NAGPIPEBELOW	32.0	.00	JAN 90
OILPIPEBELOW	68.0	.00	JAN 90
PUMP	6500.0	.00	JAN 90
TANKABOVE	160000.0	.00	JAN 05
TANKABOVE	320000.0	.00	JAN 10
SZSOFT	140000.0	.00	JAN 85
SUMPPUMPVERT	9800.0	.00	JAN 00

OTHER KEY INPUT DATA

LOCATION - NORTH CAROLINA CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
RESID	6.61	23120.0		JAN93-JAN18
NAT G	4.50	307159.0		JAN93-JAN18

Table 26b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:46:47
PROJECT NO., FY, & TITLE: FY 1992 BUILDING D-3529
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
RESIDUAL OIL	2837420.	
NATURAL GAS	29521140.	
TOTAL ENERGY COSTS		32358560.
RECURRING M&R/CUSTODIAL COSTS		9567582.
MAJOR REPAIR/REPLACEMENT COSTS		2440823.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		44366970.

*NET PW EQUIVALENTS ON JAN92; IN 10**0 DOLLARS; IN CONSTANT JAN92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 26b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:46:47
PROJECT NO., FY, & TITLE: FY 1992 BUILDING D-3529
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	RESID	NAT G	M & R	R / R	OTHER
1	150529.	1297102.	623218.	0.	0.
2	147040.	1259355.	595811.	0.	0.
3	142924.	1207327.	569609.	155709.	0.
4	136977.	1154232.	544559.	0.	0.
5	130632.	1112620.	520611.	14375.	0.
6	125438.	1079726.	497716.	0.	0.
7	122730.	1086273.	475828.	44525.	0.
8	121048.	1110411.	454902.	34054.	0.
9	119712.	1144279.	434897.	0.	0.
10	118886.	1198367.	415772.	0.	0.
11	118051.	1235814.	397487.	0.	0.
12	116921.	1248533.	380007.	0.	0.
13	115717.	1275313.	363295.	1368967.	0.
14	113805.	1289742.	347319.	0.	0.
15	111313.	1295337.	332045.	0.	0.
16	108179.	1281349.	317442.	0.	0.
17	104654.	1249972.	303482.	341244.	0.
18	101046.	1233161.	290136.	470886.	0.
19	97892.	1202666.	277377.	11063.	0.
20	95345.	1171372.	265178.	0.	0.
21	92964.	1142116.	253517.	0.	0.
22	90423.	1110895.	242368.	0.	0.
23	87865.	1079474.	231709.	0.	0.
24	85020.	1044517.	221519.	0.	0.
25	82307.	1011192.	211777.	0.	0.
***	2837420.	********	9567582.	2440823.	0.

*NET PW EQUIVALENTS ON JAN92; IN 10**0 DOLLARS; IN CONSTANT JAN92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 27a

Boiler Evaluation Parts List—Fort Bragg Bldg. E-2823

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1988	2	16	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			350	psig	385	temp	Good
2. Relief Valve(s)	1988	2	1.5	in.	340	psig	Good
2. Relief Valve(s)	1988	2	1.5	in.	350	psig	Good
3. Feedwater Regulator(s)	Manual		______	in.	______	psig	
4. Boiler Burner(s)	1988	1	______	MBtu			
5. Boiler Fan(s) (FD)	1988	2	7.5	Hp			Good
7. Boiler Drum Level Control	Visual						
B. Feedwater System							
8. Deaerating Heater	1988	1	______	lb/hr			
10. Treated Water Storage (DA Tank)	1988	1	______	gal	(3'x7')		
11. Treated Water Storage Pumps	1988	2	3	Hp			Good
13. Condensate Receiver	Expansion Tank						
14. Boiler Feed Pumps	1988	2	10	Hp			Good
17. Sediment Tank (Dump Tank)	1988	1	72	diam (in.)	18.5	length (ft)	Good
18. Expansion Tank	1988	1	96	diam (in.)	20	length (ft)	Good
19. Feedwater Piping System (valve)	1988		1	diam (in.)	15-20	psig	Good
20. Cooling Water Pumps	1988	2	60	Hp			Good
20. Cooling Water Pumps (booster)	1988	2	10	Hp			Good
20. Cooling Water Pumps (booster)	1988	1	15	Hp			Good
20. Cooling Water Pumps	1988	2	125	Hp			Good
21. HTW Distribution System Pumps	1988	2	20	Hp			Good
21. HTW Distribution System Pumps	1988	2	30	Hp			Good
C. Fuel Handling System							
3. Fuel Oil Tank - Underground	1988	1	______	gal			
4. Fuel Oil Pump	1988	1	______	gpm			
5. Fuel Oil Heater	______	______	______	gpm			
6. Fuel Oil Piping System (BLW)	1988		1	diam (in.)			Good
7. Natural Gas Piping System (BLW)	1988		3	diam (in.)			Good
D. Heat Recovery System							
E. Air Pollution Control Systems and Emission Monitoring							
5. Stack	______	______	______	diam (ft)	______	height (ft)	Good

Table 27a (Cont'd)

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
F. Combustion Controls							
2. Boiler Master	1988	2					Good
3. Flame Safeguard System	1988	2					Good
5. Additional Boiler Instrumentation/Indicators	Part of Boiler Master 1988	1		O2/CO/Opacity Monitor N2 Pressure Alarm			Good
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	1988	1	50	gal	0.25	Hp	Good
H. Make-up Water System							
9. Sodium Zeolite Softener	1988	1	31	gpm			Good
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1988	1	____	SCFM	(10 Hp)		
2. Air Dryer (REFR)	1988	1	10	SCFM			Good
3. Air Receiver	1988	1	80	gal			Good
K. Electrical System							
1. Transformer/TransPCB	____	____	____	KVA			
2. Switchgear -- Main Circuit Breaker	____	____	____	amps			
3. Motor Control Center/Starter	____	____	____	amps			
4. Emergency Generator	1988	1	250	KVA			Good
L. Physical Plant							
1. Building Siding, Roofing, Windows, and Doors	1988						Good
2. Building Concrete and Building Steel	1988						Good
4. Building Lighting	1988						Good
Building Outside Dimensions	____	Ht (ft)	____	Length (ft)	____	Width (ft)	
Building Basement (Yes/No)	____						

Table 27b

Status Quo Life Cycle Cost Analysis
for Fort Bragg Bldg E-2823

```
     LIFE CYCLE COST ANALYSIS                              STUDY: TDBRG2
LCCID  1.065                     DATE/TIME:  05-14-92  16:49:17
PROJECT NO., FY, & TITLE:         FY 1992     BUILDING E-2823
INSTALLATION & LOCATION: FORT BRAGG    NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	37692.4	1.58	JUL93-JUL17
NATURAL GAS	303300.0	3.64	JUL93-JUL17
MAINT LABOR	134400.0	.00	JUL93-JUL17
MAINT SERV	10811.0	.00	JUL93-JUL17
MAINT SUPPLY	80000.0	.00	JUL93-JUL17
MAINT UTIL	54054.0	.00	JUL93-JUL17
RELVALVE	3654.0	.00	JAN 08
RELVALVE	3666.0	.00	JAN 08
PUMPSIMPLEX	3000.0	.00	JAN 08
TANKPOLY	200.0	.00	JAN 08
BOILMASTER	10000.0	.00	JAN 18
FLAMESAFE	20000.0	.00	JAN 18
AIRCOMPRECIP	20000.0	.00	JAN 08
AIRDRYERREFR	12000.0	.00	JAN 03
AIRRECV	600.0	.00	JAN 18
EMERGENCYGEN	150571.0	.00	JAN 18
COOLPUMP	5500.0	.00	JAN 08
COOLPUMP	5500.0	.00	JAN 08
COOLPUMP	6250.0	.00	JAN 08
COOLPUMP	22800.0	.00	JAN 08
COOLPUMP	22800.0	.00	JAN 08
FEEDPUMP	28000.0	.00	JAN 18
FWPIPINGVAL	1100.0	.00	JAN 08
HTWPUMP	38000.0	.00	JAN 18
HTWPUMP	38000.0	.00	JAN 18
TREATPUMP	8000.0	.00	JAN 08
NAGPIPEBELOW	18.0	.00	JAN 13
OILPIPEBELOW	25.0	.00	JAN 13
PUMP	8000.0	.00	JAN 13

Table 27b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:49:17
PROJECT NO., FY, & TITLE: FY 1992 BUILDING E-2823
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

TANKBELOW	57000.0	.00	JAN 18
SZSOFT	70000.0	.00	JAN 08

OTHER KEY INPUT DATA

LOCATION - NORTH CAROLINA CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	7.43	5073.0		JAN93-JAN18
NAT G	4.50	67400.0		JAN93-JAN18

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LCCID  1.065                  DATE/TIME:  05-14-92  16:49:17
PROJECT NO., FY, & TITLE:      FY 1992    BUILDING E-2823
INSTALLATION & LOCATION: FORT BRAGG    NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:

                 LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                                 0.

ENERGY COSTS:

DISTILLATE OIL                         649110.
NATURAL GAS                           6626649.

TOTAL ENERGY COSTS                                 7275760.

RECURRING M&R/CUSTODIAL COSTS                      4068100.

MAJOR REPAIR/REPLACEMENT COSTS                      203734.

OTHER O&M COSTS & MONETARY BENEFITS                      0.

DISPOSAL COSTS/RETENTION VALUE                           0.

LCC OF ALL COSTS/BENEFITS (NET PW)                11547590.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91
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Table 27b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:49:17
PROJECT NO., FY, & TITLE: FY 1992 BUILDING E-2823
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	36060.	291162.	264990.	0.	0.
2	34501.	282689.	253337.	0.	0.
3	32905.	271010.	242196.	0.	0.
4	31451.	259092.	231545.	0.	0.
5	30096.	249751.	221362.	0.	0.
6	28953.	242367.	211627.	0.	0.
7	28273.	243837.	202320.	0.	0.
8	27788.	249256.	193423.	0.	0.
9	27389.	256858.	184917.	0.	0.
10	27108.	268999.	176785.	0.	0.
11	26825.	277405.	169010.	7428.	0.
12	26504.	280260.	161578.	0.	0.
13	26165.	286271.	154472.	0.	0.
14	25697.	289510.	147679.	0.	0.
15	25134.	290766.	141184.	0.	0.
16	24459.	287626.	134975.	85254.	0.
17	23719.	280583.	129039.	0.	0.
18	22903.	276809.	123365.	0.	0.
19	22184.	269964.	117939.	0.	0.
20	21607.	262939.	112753.	0.	0.
21	21067.	256372.	107794.	3175.	0.
22	20491.	249364.	103054.	0.	0.
23	19912.	242311.	98522.	0.	0.
24	19267.	234464.	94189.	0.	0.
25	18652.	226984.	90047.	0.	0.
***	649110.	6626649.	4068100.	203734.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 28a

Boiler Evaluation Parts List—Fort Bragg Bldg. N-6002

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1985	2	25	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			110	psig	345	temp	Good
2. Relief Valve(s)	1985	3	1.5	in.	400	psig	Good
2. Relief Valve(s)	1991	1	1.5	in.	400	psig	Good
3. Feedwater Regulator(s)	Base water supply		____	in.	____	psig	
4. Boiler Burner(s)	1985	2	25	MBtu			Good
5. Boiler Fan(s) (FD)	1985	2	15	Hp			Good
7. Boiler Drum Level Control	Manual						
B. Feedwater System							
8. Deaerating Heater	None			lb/hr			
14. Zone Pumps	____	____	10	Hp			
15. Make-up Pumps	1985	2	15	Hp			Good
16. Boiler Circulating Water Pumps	1985	3	10	Hp			Good
18. Expansion Tank	1985	1	72	diam (in.)	20	length (ft)	Good
19. Feedwater Piping System (valve)	Base water pressure		____	diam (in.)	____	psig	
20. Cooling Water Pumps	1985	2	200	Hp			Good
21. HTW Distribution System Pumps	1985	2	75	Hp			Good
C. Fuel Handling System							
3. Fuel Oil Tank - Underground	1985	1	30000	gal			Good
4. Fuel Oil Pump	____	____	____	gpm			
5. Fuel Oil Heater	____	____	____	gpm			
6. Fuel Oil Piping System (BLW)	____		____	diam (in.)			
7. Natural Gas Piping System (BLW)	1985		2.5	diam (in.)			Good
D. Heat Recovery System							Good
E. Air Pollution Control Systems and Emission Monitoring							
5. Stack	1985	1	48	diam (ft)	80	height (ft)	Good
F. Combustion Controls							
1. Plant Master	1985	1					Good
2. Boiler Master	1985	2					Good
3. Flame Safeguard System	1985	2					Good
5. Additional Boiler Instrumentation/Indicators	1985	1		O2/CO2 Recorders Low water level cut-off			Good

Table 28a (Cont'd)

Equipment	Year Installed	Units	Specification 1	Specification 2	Condition
G. Chemical Feed System					
1. Chemical Storage Tanks and Pumps	1985	2	50 gal		Good
H. Make-up Water System					
9. Sodium Zeolite Softener	1985	1	50 gpm	(Solar Rock Salt)	Good
I. Condensate Polishing					
J. Compressed Air System					
1. Air Compressor (RECIP)	1985	2	____ SCFM		
3. Air Receiver	1985	2	120 gal		Good
Soot blower - used daily to maintain it					Good
1. Air Compressor (RECIP)	1985	1	____ SCFM	(3 Hp)	
2. Air Dryer (REFR)	1985	1	105 SCFM		Good
3. Air Receiver	1985	1	____ gal	(4'x8')	
K. Electrical System					
1. Transformer/TransPCB	____	____	____ KVA		
2. Switchgear -- Main Circuit Breaker	1985	1	400 amps		Good
3. Motor Control Center/Starter	____	____	____ amps		
4. Emergency Generator	1985	1	113 KVA		Good
L. Physical Plant					
1. Building Siding, Roofing, Windows, and Doors	1985				Good
2. Building Concrete and Building Steel	1985				Good
3. Sump Pump (SUBMERGE/VERTICAL)	1985	3	40 gpm		Good
4. Building Lighting	1985				Good
Building Outside Dimensions	____	Ht (ft)	____ Length (ft)	____ Width (ft)	
Building Basement (Yes/No)	____				

Table 28b

Status Quo Life Cycle Cost Analysis
for Fort Bragg Bldg N-6002

```
     LIFE CYCLE COST ANALYSIS                         STUDY: TDBRG4
LCCID  1.065                      DATE/TIME:  05-14-92  16:44:33
PROJECT NO., FY, & TITLE:          FY 1992    BUILDING N-6002
INSTALLATION & LOCATION: FORT BRAGG    NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	JAN 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
RESIDUAL OIL	37663.8	2.21	JUL93-JUL17
NATURAL GAS	340659.0	3.39	JUL93-JUL17
MAINT LABOR	134400.0	.00	JUL93-JUL17
MAINT SERV	13514.0	.00	JUL93-JUL17
MAINT SUPPLY	100000.0	.00	JUL93-JUL17
MAINT UTIL	67568.0	.00	JUL93-JUL17
RELVALVE	5601.0	.00	JAN 05
RELVALVE	1867.0	.00	JAN 11
TANKPOLY	400.0	.00	JAN 05
BOILMASTER	10000.0	.00	JAN 15
FLAMESAFE	20000.0	.00	JAN 15
PLANTMASTER	5000.0	.00	JAN 15
AIRCOMPRECIP	40000.0	.00	JAN 05
AIRCOMPRECIP	20000.0	.00	JAN 05
AIRDRYERREFR	13300.0	.00	JAN 00
AIRRECV	1400.0	.00	JAN 15
AIRRECV	3000.0	.00	JAN 15
EMERGENCYGEN	71660.0	.00	JAN 15
CIRCPUMP	42000.0	.00	JAN 15
COOLPUMP	22800.0	.00	JAN 05
FWPIPINGVAL	1100.0	.00	JAN 05
HTWPUMP	57000.0	.00	JAN 15
HTWPUMP	46000.0	.00	JAN 15
MUPUMP	12500.0	.00	JAN 05
NAGPIPEBELOW	16.0	.00	JAN 10
TANKBELOW	42000.0	.00	JAN 15
SZSOFT	70000.0	.00	JAN 05
SUMPPUMPVERT	15225.0	.00	JAN 00

Table 28b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:44:33
PROJECT NO., FY, & TITLE: FY 1992 BUILDING N-6002
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

===

OTHER KEY INPUT DATA

LOCATION - NORTH CAROLINA CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
RESID	6.61	5698.0		JAN93-JAN18
NAT G	4.50	75702.0		JAN93-JAN18

Table 28b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:44:33
PROJECT NO., FY, & TITLE: FY 1992 BUILDING N-6002
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
RESIDUAL OIL	699291.	
NATURAL GAS	7275742.	
TOTAL ENERGY COSTS		7975034.
RECURRING M&R/CUSTODIAL COSTS		4527299.
MAJOR REPAIR/REPLACEMENT COSTS		222730.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		12725060.

*NET PW EQUIVALENTS ON JAN92; IN 10**0 DOLLARS; IN CONSTANT JAN92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 28b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:44:33
PROJECT NO., FY, & TITLE: FY 1992 BUILDING N-6002
INSTALLATION & LOCATION: FORT BRAGG NORTH CAROLINA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	RESID	NAT G	M & R	R / R	OTHER
1	37098.	319682.	294902.	0.	0.
2	36239.	310379.	281933.	0.	0.
3	35224.	297556.	269534.	0.	0.
4	33759.	284471.	257681.	0.	0.
5	32195.	274215.	246349.	0.	0.
6	30915.	266108.	235515.	0.	0.
7	30247.	267721.	225158.	0.	0.
8	29833.	273671.	215256.	19905.	0.
9	29504.	282017.	205790.	0.	0.
10	29300.	295348.	196740.	0.	0.
11	29094.	304577.	188088.	0.	0.
12	28816.	307712.	179816.	0.	0.
13	28519.	314312.	171908.	96079.	0.
14	28048.	317868.	164348.	0.	0.
15	27433.	319247.	157121.	0.	0.
16	26661.	315799.	150211.	0.	0.
17	25792.	308066.	143605.	0.	0.
18	24903.	303923.	137290.	7.	0.
19	24126.	296407.	131252.	794.	0.
20	23498.	288695.	125480.	0.	0.
21	22911.	281484.	119962.	0.	0.
22	22285.	273790.	114686.	0.	0.
23	21655.	266046.	109643.	105944.	0.
24	20953.	257430.	104821.	0.	0.
25	20285.	249217.	100211.	0.	0.
***	699291.	7275742.	4527299.	222730.	0.

*NET PW EQUIVALENTS ON JAN92; IN 10**0 DOLLARS; IN CONSTANT JAN92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 29

CHPECON Run Results for Fort Bragg Bldg. C-1432

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
GAS	100/100/100	10.588	12.659	9051	118957	137895	100
#2 OIL	100/100/100	15.795	18.884	9051	186764	205702	149
#6 OIL	100/100/100	16.885	20.187	9051	200957	219895	159
STOKER	68/117/117/117	10.538	12.599	62367	38337	137239	100
CWS	59/117/150/150	10.372	12.401	53143	58437	141162	102
COM	71/123/123/123	16.138	19.295	37872	156267	219633	159
FBC	54/108/138/138	10.388	12.420	60181	40010	135292	98
				K$INV	K$COAL	K$ HVY OIL	SAVINGS
Retrofit							
STOKER				4575	36441	-215732	-174717
CWS				3787	55131	-298123	-239205
M-COAL				5888	35296	-210934	-169750

FILE PREFIX: FBG3
PMCR: 300 L
AVE MON. LOAD: 100 M
L=(K# STEAM/HR)
M=(MBTU/HR)

Table 30

CHPECON Run Results for Fort Bragg Bldg. D-3529

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
#6 OIL	44/44/44	17.915	21.420	5715	86537	100328	154
STOKER	30/51/51/51	15.310	18.305	41825	17324	85737	132
CWS	26/51/65/65	13.515	16.159	31118	25665	79092	122
COM	31/53/53/53	19.358	23.145	25001	67880	113287	174
FBC	24/47/60/60	14.884	17.795	39757	17565	83350	128
				K$INV	K$COAL	K$ HVY OIL	SAVINGS
Retrofit							
STOKER				4500	15732	-93136	-72903
CWS				3211	23886	-129165	-102068
M-COAL				5302	15107	-90291	-69881

FILE PREFIX: FBG1
PMCR: 130 L
AVE MON. LOAD: 43 M
CHP #1 3@ 26 M FUEL = NG/FS6 AGE = 1965
1@ 26 M FUEL = NG/FS6 AGE = 1969
L=(K# STEAM/HR)
M=(MBTU/HR)

Table 31

CHPECON Run Results for Fort Bragg Bldg. N-6002

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
#2 OIL	17/17/17	19.494	23.307	4020	31926	43159	136
#6 OIL	17/17/17	20.584	24.610	4020	34339	45572	144
STOKER	12/20/20/20	27.603	33.002	32334	7595	61111	193
CWS	10/20/25/25	21.877	26.150	21129	10605	50615	160
COM	12/21/21/21	27.791	33.227	18719	27526	64296	203
FBC	9/18/23/23	26.575	31.774	30190	7501	58837	186
				K$INV	K$COAL	K$ HVY OIL	SAVINGS
Retrofit							
STOKER							
CWS							
M-COAL							

FILE PREFIX: FBG5
PMCR: 50 L
AVE MON. LOAD: 17 M
CHP #5 2@ 25 L FUEL = NG,FS6 AGE = 1985
L = (K# STEAM/HR)
M = (MBTU/HR)

Table 32

CHPECON Run Results for Fort Bragg Bldg. 4-3124

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
GAS	42/42/42	11.656	13.936	5625	50088	67757	100
#2 OIL	42/42/42	16.863	20.161	5625	78568	92237	136
#6 OIL	42/42/42	17.953	21.464	5625	84529	98198	145
STOKER	29/49/49/49	15.490	18.521	41320	16975	84731	125
CWS	25/49/63/63	13.650	16.321	30776	25051	78026	115
COM	30/52/52/52	19.358	23.144	24442	65901	110648	163
FBC	23/46/58/58	15.049	17.992	39269	17147	82311	121
				K$INV	K$COAL	K$ HVY OIL	SAVINGS
Retrofit							
STOKER				3361	15381	-91056	-72314
CWS				2273	23295	-125967	-100400
M-COAL				3904	14764	-88234	-69565

FILE PREFIX: FBG2
PMCR: 126 L
AVE MON. LOAD: 42 M
CHP #2 2@ 37.9 L FUEL = NG,FS2 AGE = 1972
1@ 50 L FUEL = NG,FS2 AGE = 1952
L=(K# STEAM/HR)
M=(MBTU/HR)

Table 33

CHPECON Run Results for Fort Bragg Bldg. C-7549

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
GAS	34/34/34	12.133	14.506	5028	39387	52145	100
#2 OIL	34/34/34	17.340	20.732	5028	61764	74522	143
#6 OIL	34/34/34	18.430	22.034	5028	66447	79205	152
STOKER	23/39/39/39	17.292	20.675	37447	13377	74318	143
CWS	20/39/50/50	15.209	18.184	27421	19703	68307	131
COM	24/41/41/41	20.829	24.905	22346	51578	93547	179
FBC	18/36/46/46	16.875	20.176	35433	13658	72526	139
				K$INV	K$COAL	K$ HVY OIL	SAVINGS
Retrofit							
STOKER							
CWS							
M-COAL							

FILE PREFIX: FBG4
PMCR: 100 L
AVE MON. LOAD: 33 M
CHP #4 2@ 50 L FUEL = NG,FS2 AGE = 1973
L=(K# STEAM/HR)
M=(MBTU/HR)

Table 34

Cost Sensitivity Analysis for a Gas/#2 Oil-Fired Boiler Plant

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 1
File: FBGG Type: New plant (NP) 05/11/92
Desc: FORT BRAGG
Tech: Gas / Oil Fired Boiler

****
Base and Plant Information
****

State: NC - North Carolina Base DOE Region: 3
PMCR: 379,000 lb/hr steam Number of boilers: 3

Height of the plant: 40 ft
Building area: 10200 sq ft
Plant area: 2.44 acres

****
Facility Parameters
****

Capital Equipment Escalation Factor: 1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor: 1.106 (947.10/1991)
Operation & Maintenance Labor Escalation Factor: 1.061 (4386.55/1991)
Construction Labor Escalation Factor: 1.030 (272.70/1991)

Annual electricity usage: 2,051,666 kW-hr

1991 cost for distillate: 0.631 $/gallon
1991 cost for residual: 0.400 $/gallon
1991 cost for natural gas: 2.722 $/million Btu
1991 cost for electricity: 0.053 $/kW-hr

Annual Facility Output: 1,159,392 thousand lb steam
Annual Natural Gas Usage: 1,423 10^6 SCF
Heating plant efficiency: 83.2% natural gas
Year of Study: 1991
Years of Operation: 1995 - 2019
Annual #2 Fuel Oil Usage: 11,200 10^3 gal
Heating plant efficiency: 86.2% #2 fuel oil

****
Facility Capital Costs
****

Equipment		Cost	Equipment		Cost
Boiler:	$	2,242,793	Stack:	$	32,911
Building/service:	$	1,621,511	Water trtmnt:	$	930,583
Feedwtr pmps:	$	43,085	Cond xfr pmps:	$	46,709
Cond strg tnk:	$	10,835	Oil (long) storage:	$	476,208
Oil day strg pmp:	$	5,642	Oil heaters:	$	12,224
Oil day strg tanks:	$	28,304	Oil unload pumps:	$	13,791
Oil xfr pmps:	$	7,992	Fire protection:	$	52,241
Cont bldn tnk:	$	1,512	Intr bldn tnk:	$	1,512
Compressor:	$	24,453	Car puller:	$	20,896
Rail:	$	22,202	Site preparation:	$	6,373
Site improvements:	$	302,476	Mobile equipment:	$	40,748

Table 34 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 2
File: FBGG Type: New plant (NP) 05/11/92
Desc: FORT BRAGG
Tech: Gas / Oil Fired Boiler

****
Facility Capital Costs, cont
****

Piping: $ 1,484,057 Instrumentation: $ 548,726
Direct costs: $ 3,125,845
****
Plant installed cost: $ 12,247,402

****
Facility Annual O & M and Energy Costs
****

Operating staff: 12
Annual Labor Costs: $ 499,778
Annual Year Non-Labor O & M Costs : $ 832,832
1995 Natural gas costs : $ 5,000,592
1995 Auxiliary Energy Costs : $ 108,982
1995 #2 fuel oil costs : $ 8,610,956

****
Periodic Major Maintenance Cost Summary
****

Time Interval		Cost	Time Interval		Cost
3 years	$	30,000	5 years	$	7,075
10 years	$	386,834	15 years	$	151,802
18 years	$	18,684	20 years	$	16,651

****
Facility Life Cycle Cost Summary
****

Analysis using natural gas as primary fuel

+ PV 'Adjusted' Investment Costs	= $ 10,732,356
+ PV Energy + Transportation Costs	= $ 106,846,953
+ PV Annually Recurring O&M Costs	= $ 10,802,151
+ PV Non-Annually Recurring Repair & Replacement	= $ 579,314
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 128,960,776

Levelized Cost of Service (1995 start) = 7.4820 $/MMBtu
Levelized Cost of Service (1995 start) = 8.9454 $/1000 lb steam

****
Facility Life Cycle Cost Summary
****

Analysis using #2 fuel oil as primary fuel

Table 34 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 3
File: FBGG Type: New plant (NP) 05/11/92
Desc: FORT BRAGG
Tech: Gas / Oil Fired Boiler

****

Facility Life Cycle Cost Summary, cont

****

+ PV Energy + Transportation Costs	= $ 152,268,430
+ PV Annually Recurring O&M Costs	= $ 10,802,151
+ PV Non-Annually Recurring Repair & Replacement	= $ 579,314
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 174,382,254

Levelized Cost of Service (1995 start) = 10.117 $/MMBtu
Levelized Cost of Service (1995 start) = 12.096 $/1000 lb steam

****

Sensitivity Analysis

****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	52,659,465	76,301,311	5.292
60%	63,191,358	86,833,204	6.023
70%	73,723,252	97,365,097	6.753
80%	84,255,145	107,896,990	7.484
90%	94,787,038	118,428,883	8.214
100%	105,318,931	128,960,776	8.945
110%	115,850,824	139,492,670	9.676
120%	126,382,717	150,024,563	10.406
130%	136,914,610	160,556,456	11.137
140%	147,446,504	171,088,349	11.867
150%	157,978,397	181,620,242	12.598

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	73,417,365	97,059,211	6.732
-2%	82,490,021	106,131,866	7.361
-1%	93,034,992	116,676,837	8.093
0%	105,318,931	128,960,776	8.945
1%	119,658,535	143,300,380	9.940
2%	136,429,937	160,071,782	11.103
3%	156,079,829	179,721,674	12.466
4%	179,138,616	202,780,462	14.066
5%	206,235,971	229,877,817	15.945
6%	238,119,197	261,761,042	18.157

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	1,222,417	128,655,172	8.924

Table 34 (Cont'd)

****

Sensitivity Analysis, cont

****

100%	1,528,022	128,960,776	8.945
110%	1,680,824	129,113,579	8.956
120%	1,833,626	129,266,381	8.966

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	5,195,256	127,661,962	8.855
90%	5,844,663	128,311,369	8.900
100%	6,494,070	128,960,776	8.945
110%	7,143,477	129,610,183	8.990
120%	7,792,884	130,259,590	9.035

=== O&M non-labor cost variation ===

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	3,446,465	128,099,160	8.885
90%	3,877,273	128,529,968	8.915
100%	4,308,081	128,960,776	8.945
110%	4,738,889	129,391,585	8.975
120%	5,169,698	129,822,393	9.005

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	463,451	128,844,914	8.937
90%	521,383	128,902,845	8.941
100%	579,314	128,960,776	8.945
110%	637,246	129,018,708	8.949
120%	695,177	129,076,639	8.953

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	8,585,885	126,573,245	8.779
90%	9,659,121	127,767,011	8.862
100%	10,732,356	128,960,776	8.945
110%	11,805,592	130,154,542	9.028
120%	12,878,828	131,348,308	9.111

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Table 34 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 5
File: FBGG   Type: New plant (NP)   05/11/92
Desc: FORT BRAGG
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

-15%	-320,820	129,281,597	8.967
-10%	-213,880	129,174,657	8.960
-5%	-106,940	129,067,717	8.952
0%	0	128,960,776	8.945
5%	106,940	128,853,836	8.938
10%	213,880	128,746,896	8.930
15%	320,820	128,639,956	8.923

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	256,519,232	17.793
0.5%	235,989,485	16.369
1.5%	200,800,336	13.928
2.5%	172,065,641	11.935
3.5%	148,462,758	10.298
4.5%	128,960,776	8.945
5.5%	112,752,497	7.821
6.5%	99,203,005	6.881
7.5%	87,810,626	6.091
8.5%	78,177,169	5.422
9.5%	69,985,149	4.854
10.5%	62,980,290	4.368
11.5%	56,958,023	3.950
12.0%	54,262,405	3.763

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	61,410,016	7.982
11 yr	66,395,605	8.007
12 yr	71,413,865	8.055
13 yr	76,461,434	8.122
14 yr	81,481,943	8.198
15 yr	86,536,921	8.288
16 yr	91,378,302	8.366
17 yr	96,069,923	8.440
18 yr	100,646,253	8.513
19 yr	105,071,556	8.581
20 yr	109,517,217	8.659
21 yr	113,678,513	8.722
22 yr	117,688,331	8.781
23 yr	121,570,571	8.838
24 yr	125,329,299	8.893
25 yr	128,960,776	8.945

Table 35

Cost Sensitivity Analysis for a #6 Oil-Fired Boiler Plant

```
Central Heating Plant Economics Evaluation -- Sensitivity Analysis      Page 1
File: FBG6          Type: New plant (NP)                              07/29/92
Desc: FORT BRAGG
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Base and Plant Information
******************************************************************************

State: NC - North Carolina          Base DOE Region: 3
PMCR: 379,000 lb/hr steam         Number of boilers: 3

Height of the plant: 40 ft
Building area: 10200 sq ft
Plant area: 2.44 acres

******************************************************************************
   Facility Parameters
******************************************************************************

Capital Equipment Escalation Factor:  1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor:  1.106 ( 947.10/1991)
Operation & Maintenance Labor Escalation Factor:  1.061 (4386.55/1991)
Construction Labor Escalation Factor:  1.030 ( 272.70/1991)

Annual electricity usage: 2,051,666 kW-hr

1991 cost for distillate:  0.631 $/gallon
1991 cost for residual:  0.400 $/gallon
1991 cost for natural gas:  2.722 $/million Btu
1991 cost for electricity:  0.053 $/kW-hr

Annual Facility Output: 1,159,392 thousand lb steam
Annual #6 Fuel Oil Usage: 10,155 10^3 gal
Heating plant efficiency: 87.8% #6 fuel oil
Year of Study: 1991
Years of Operation: 1995 - 2019

******************************************************************************
   Facility Capital Costs
******************************************************************************
```

Equipment		Cost	Equipment		Cost
Boiler:	$	2,242,793	Stack:	$	32,911
Building/service:	$	1,621,511	Water trtmnt:	$	930,583
Feedwtr pmps:	$	43,085	Cond xfr pmps:	$	46,709
Cond strg tnk:	$	10,835	Oil (long) storage:	$	476,208
Oil day strg pmp:	$	5,642	Oil heaters:	$	12,224
Oil day strg tanks:	$	28,304	Oil unload pumps:	$	13,791
Oil xfr pmps:	$	7,992	Fire protection:	$	52,241
Cont bldn tnk:	$	1,512	Intr bldn tnk:	$	1,512
Compressor:	$	24,453	Car puller:	$	20,896
Rail:	$	22,202	Site preparation:	$	6,373
Site improvements:	$	302,476	Mobile equipment:	$	40,748
Elec substation:	$	83,490	Electrical:	$	261,892
Piping:	$	1,484,057	Instrumentation:	$	548,726
Direct costs:	$	3,125,845			

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 2
File: FBG6 Type: New plant (NP) 07/29/92
Desc: FORT BRAGG
Tech: Gas / Oil Fired Boiler

****
Facility Capital Costs, cont
****

Plant installed cost: $ 12,247,402

****
Facility Annual O & M and Energy Costs
****

Operating staff: 12
Annual Labor Costs: $ 499,778
Annual Year Non-Labor O & M Costs : $ 832,832
1995 #6 fuel oil costs : $ 5,457,879
1995 Auxiliary Energy Costs : $ 108,982

****
Periodic Major Maintenance Cost Summary
****

Time Interval	Cost	Time Interval	Cost
3 years	$ 30,000	5 years	$ 7,075
10 years	$ 386,834	15 years	$ 151,802
18 years	$ 18,684	20 years	$ 16,651

****
Facility Life Cycle Cost Summary
****

Analysis using #6 fuel oil as primary fuel

+ PV 'Adjusted' Investment Costs	= $ 10,732,356
+ PV Energy + Transportation Costs	= $ 108,534,041
+ PV Annually Recurring O&M Costs	= $ 10,802,151
+ PV Non-Annually Recurring Repair & Replacement	= $ 579,314
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 130,647,864

Levelized Cost of Service (1995 start) = 7.5798 $/MMBtu
Levelized Cost of Service (1995 start) = 9.0625 $/1000 lb steam

****
Sensitivity Analysis
****

=== Primary fuel initial·cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	53,503,009	77,144,855	5.351
60%	64,203,611	87,845,457	6.093

Table 35 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 3
File: FBG6 Type: New plant (NP) 07/29/92
Desc: FORT BRAGG
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

80%	85,604,815	109,246,660	7.578
90%	96,305,417	119,947,262	8.320
100%	107,006,019	130,647,864	9.062
110%	117,706,621	141,348,466	9.804
120%	128,407,222	152,049,068	10.547
130%	139,107,824	162,749,670	11.289
140%	149,808,426	173,450,272	12.031
150%	160,509,028	184,150,874	12.773

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	75,748,941	99,390,786	6.894
-2%	84,673,485	108,315,330	7.513
-1%	95,008,379	118,650,224	8.230
0%	107,006,019	130,647,864	9.062
1%	120,965,924	144,607,770	10.030
2%	137,243,569	160,885,414	11.159
3%	156,260,827	179,902,672	12.479
4%	178,518,333	202,160,179	14.023
5%	204,610,094	228,251,940	15.832
6%	235,240,735	258,882,581	17.957

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	1,222,417	130,342,260	9.041
90%	1,375,219	130,495,062	9.051
100%	1,528,022	130,647,864	9.062
110%	1,680,824	130,800,666	9.073
120%	1,833,626	130,953,469	9.083

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	5,195,256	129,349,050	8.972
90%	5,844,663	129,998,457	9.017
100%	6,494,070	130,647,864	9.062
110%	7,143,477	131,297,271	9.107
120%	7,792,884	131,946,678	9.152

=== O&M non-labor cost variation ===

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	3,446,465	129,786,248	9.002
90%	3,877,273	130,217,056	9.032
100%	4,308,081	130,647,864	9.062
110%	4,738,889	131,078,672	9.092

Table 35 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 4
File: FBG6 Type: New plant (NP) 07/29/92
Desc: FORT BRAGG
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	463,451	130,532,001	9.054
90%	521,383	130,589,933	9.058
100%	579,314	130,647,864	9.062
110%	637,246	130,705,796	9.066
120%	695,177	130,763,727	9.070

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	8,585,885	128,260,333	8.896
90%	9,659,121	129,454,098	8.979
100%	10,732,356	130,647,864	9.062
110%	11,805,592	131,841,630	9.145
120%	12,878,828	133,035,396	9.228

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-320,820	130,968,685	9.084
-10%	-213,880	130,861,744	9.077
-5%	-106,940	130,754,804	9.069
0%	0	130,647,864	9.062
5%	106,940	130,540,924	9.055
10%	213,880	130,433,984	9.047
15%	320,820	130,327,044	9.040

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	255,269,595	17.707
0.5%	235,312,174	16.322
1.5%	201,032,108	13.944
2.5%	172,956,540	11.997
3.5%	149,823,413	10.392
4.5%	130,647,864	9.062
5.5%	114,657,756	7.953
6.5%	101,244,910	7.022
7.5%	89,928,064	6.237
8.5%	80,324,620	5.571

Table 35 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 5
File: FBG6 Type: New plant (NP) 07/29/92
Desc: FORT BRAGG
Tech: Gas / Oil Fired Boiler

****
Sensitivity Analysis, cont
****

10.5%	65,096,066	4.515
11.5%	59,028,170	4.094
12.0%	56,304,866	3.905

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	65,879,232	8.563
11 yr	71,036,145	8.566
12 yr	76,105,266	8.584
13 yr	81,043,821	8.608
14 yr	85,852,414	8.638
15 yr	90,623,666	8.679
16 yr	95,188,959	8.715
17 yr	99,613,272	8.751
18 yr	103,930,232	8.791
19 yr	108,103,900	8.829
20 yr	112,305,490	8.880
21 yr	116,231,144	8.918
22 yr	120,013,460	8.955
23 yr	123,675,606	8.991
24 yr	127,221,878	9.027
25 yr	130,647,864	9.062

Table 36

Cost Sensitivity Analysis for a Coal-Fired Stoker Plant

```
Central Heating Plant Economics Evaluation -- Sensitivity Analysis        Page 1
File: FBGC          Type: New plant (NP)                                  07/29/92
Desc: FORT BRAGG
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

******************************************************************************
   Base and Plant Information
******************************************************************************

State: NC - North Carolina        Base DOE Region: 3
PMCR: 379,000 lb/hr steam     Number of boilers: 4

Coal code: W205320                          Distance from base:   294 miles
State: KY - Kentucky                        DOE Region:  3
Coal type: bituminous                   (properties on a dry basis)
     hhv: 12870 Btu/lb    fixed carbon:  52.20%    volatiles:  38.10%
     ash:    9.70%    sulfur:    0.50%

Coal handling equipment capacity: 200 tons/hr
Coal silo storage capacity: 1426 tons
Approx. building width: 84 feet
Approx. building length: 252 feet
Height of the plant: 91 ft
Building area: 21072 sq ft
Plant area: 2.63 acres

******************************************************************************
   Facility Parameters
******************************************************************************

Capital Equipment Escalation Factor:  1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor:  1.106 ( 947.10/1991)
Operation & Maintenance Labor Escalation Factor:  1.061 (4386.55/1991)
Construction Labor Escalation Factor:  1.030 ( 272.70/1991)

Annual diesel/distillate fuel usage: 17,516 gallons
Annual electricity usage: 6,373,949 kW-hr
Annual lime usage: 1,176 tons

1991 cost for coal:  1.715 $/MMBtu
1991 cost for distillate:  0.631 $/gallon
1991 cost for electricity:  0.053 $/kW-hr

Annual Facility Output: 1,159,392 thousand lb steam
Annual Coal Usage: 60,569 tons (dry)  /  64,204 tons (wet)
Heating plant efficiency: 84%
Year of Study: 1991
Years of Operation: 1995 - 2019

******************************************************************************
   Facility Installed Capital Costs
******************************************************************************
```

Equipment		Cost	Equipment		Cost
Boiler:	$	18,234,113	Coal Handling:	$	7,109,178
Ash Handling:	$	2,563,757	Mechncl Collector:	$	219,181

Table 36 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 2
File: FBGC   Type: New plant (NP)   07/29/92
Desc: FORT BRAGG
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

Facility Installed Capital Costs, cont

Water Treatment:	$	1,440,954	Pumps:	$	359,045
Air Compressor:	$	113,612	Waste Water Trtmnt:	$	156,176
Piping/Stack:	$	6,123,282	Electrical System:	$	1,789,999
Building Costs:	$	13,437,622	Direct costs:	$	20,670,555

Plant installed cost: $ 83,110,049

Facility Annual O & M and Energy Costs

Operating staff: 34
Annual Labor Costs: $ 1,455,295
First Year Non-Labor O & M Costs : $ 2,465,522
Annual Year Non-Labor O & M Costs : $ 2,885,447
1995 Coal Costs (incl transport) : $ 3,324,765
1995 Auxiliary Energy Costs : $ 352,044

Periodic Major Maintenance Cost Summary

Time Interval	Cost	Time Interval	Cost
3 years	$ 144,735	5 years	$ 126,244
7 years	$ 131,192	8 years	$ 449,078
10 years	$ 950,959	12 years	$ 85,105
15 years	$ 23,650	18 years	$ 37,366
20 years	$ 1,525,196		

Facility Life Cycle Cost Summary

+ PV 'Adjusted' Investment Costs	= $ 72,829,053
+ PV Energy + Transportation Costs	= $ 52,914,546
+ PV Annually Recurring O&M Costs	= $ 37,141,111
+ PV Non-Annually Recurring Repair & Replacement	= $ 3,217,968
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 166,102,680

Levelized Cost of Service (1995 start) = 9.6368 $/MMBtu

Table 36 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 3
File: FBGC   Type: New plant (NP)   07/29/92
Desc: FORT BRAGG
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****

Sensitivity Analysis

****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	23,965,836	142,136,844	9.859
60%	28,759,004	146,930,011	10.191
70%	33,552,171	151,723,178	10.524
80%	38,345,338	156,516,346	10.856
90%	43,138,506	161,309,513	11.189
100%	47,931,673	166,102,680	11.521
110%	52,724,840	170,895,848	11.854
120%	57,518,008	175,689,015	12.186
130%	62,311,175	180,482,183	12.519
140%	67,104,342	185,275,350	12.851
150%	71,897,510	190,068,517	13.184

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	34,739,514	152,910,522	10.606
-2%	38,523,048	156,694,055	10.869
-1%	42,886,234	161,057,242	11.171
0%	47,931,673	166,102,680	11.521
1%	53,781,039	171,952,046	11.927
2%	60,578,650	178,749,658	12.399
3%	68,495,693	186,666,700	12.948
4%	77,735,213	195,906,220	13.589
5%	88,538,020	206,709,028	14.338
6%	101,189,659	219,360,667	15.216

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	3,986,298	165,106,106	11.452
90%	4,484,586	165,604,393	11.487
100%	4,982,873	166,102,680	11.521
110%	5,481,160	166,600,968	11.556
120%	5,979,448	167,099,255	11.590

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	15,127,986	162,320,684	11.259
90%	17,018,984	164,211,682	11.390
100%	18,909,982	166,102,680	11.521
110%	20,800,980	167,993,679	11.653
120%	22,691,979	169,884,677	11.784

=== O&M non-labor cost variation ===

Table 36 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 4
File: FBGC Type: New plant (NP) 07/29/92
Desc: FORT BRAGG
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Sensitivity Analysis, cont
****

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	14,584,903	162,456,455	11.268
90%	16,408,015	164,279,568	11.395
100%	18,231,128	166,102,680	11.521
110%	20,054,241	167,925,793	11.648
120%	21,877,354	169,748,906	11.774

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	2,574,375	165,459,087	11.477
90%	2,896,171	165,780,884	11.499
100%	3,217,968	166,102,680	11.521
110%	3,539,765	166,424,477	11.544
120%	3,861,562	166,746,274	11.566

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	58,263,243	149,121,218	10.343
90%	65,546,148	157,611,949	10.932
100%	72,829,053	166,102,680	11.521
110%	80,111,959	174,593,412	12.110
120%	87,394,864	183,084,143	12.699

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-2,109,977	168,212,658	11.668
-10%	-1,406,651	167,509,332	11.619
-5%	-703,325	166,806,006	11.570
0%	0	166,102,680	11.521
5%	703,325	165,399,355	11.473
10%	1,406,651	164,696,029	11.424
15%	2,109,977	163,992,703	11.375

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	266,365,451	18.476
0.5%	250,785,946	17.396
1.5%	223,700,223	15.517

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 5
File: FBGC Type: New plant (NP) 07/29/92
Desc: FORT BRAGG
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Sensitivity Analysis, cont
****

3.5%	182,155,073	12.635
4.5%	166,102,680	11.521
5.5%	152,413,939	10.572
6.5%	140,654,135	9.756
7.5%	130,477,977	9.050
8.5%	121,609,843	8.435
9.5%	113,828,614	7.895
10.5%	106,956,012	7.419
11.5%	100,847,576	6.995
12.0%	98,042,265	6.800

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	120,349,774	15.644
11 yr	124,097,923	14.965
12 yr	127,827,924	14.418
13 yr	131,308,889	13.948
14 yr	134,721,953	13.555
15 yr	138,077,818	13.224
16 yr	141,378,128	12.944
17 yr	144,371,444	12.684
18 yr	147,328,849	12.462
19 yr	150,109,897	12.260
20 yr	153,736,320	12.156
21 yr	156,416,595	12.002
22 yr	158,908,029	11.857
23 yr	161,310,050	11.727
24 yr	163,832,833	11.625
25 yr	166,102,680	11.521

Table 37

Fort Gordon Heating Plant Information

Plant	Boiler	Fuel	Reserve	Year Installed	Capacity (lb/hr)	In use	Rating	Energy Use Heat/Cool/ Process/Losses/ Internal/Pwr gen
25330	1	Nat. Gas	FS2	1975	35000	Y	7	H/C
25330	2	Nat. Gas	FS2	1975	35000	Y	7	H/C
2202	1	Nat. Gas	FS2	1972	30000	Y	7	H
2202	2	Nat. Gas	FS2	1972	30000	Y	7	H
25910	1	Nat. Gas	FS2	1965	35850	Y	6	H/C
25910	2	Nat. Gas	FS2	1965	35850	Y	6	H/C
25910	3	Nat. Gas	FS2	1965	35850	Y	6	H/C
25910	4	Nat. Gas	FS2	1967	34000	Y	6	H/C
25910	5	Nat. Gas	FS2	1967	34000	Y	6	H/C
310	1	Nat. Gas	FS2	1972	15300	Y	5	H/C
310	2	Nat. Gas	FS2	1972	15300	Y	5	H/C
310	3	Nat. Gas	FS2	1972	15300	Y	5	H/C
				(Total)	351450			

Table 38

Fort Gordon Energy Use Data

Fuel	Units	Btu/Unit	$/Unit	1989 Use	1990 Use	$/MBtu	MBtu '90
Dist. oil	gal	138000	0.56	610386	700014	4.06	96602
Res. oil	gal			0	0		
Nat. gas	Total NAG use:			593517	532434		547342
Interr.	kscf	1028000	2.88			2.80	
Unintr.	kscf	1028000	5.65			5.50	
Building:		25910	310	25330	2202		
Capacity (lb/hr):		175550	45900	7000)	60000		
SQ file:		GRD1	GRD2	GRD3	GRD4		
Annual Costs							
Labor*		385000	122500	167500	167500		
Utilities*		237230	62027	94595	81081		
Service*		47446	12405	18919	16216		
Supplies*		320880	91800	140000	120000		
Average steam production, 1990 (lb/hr):							
October		13829	5717.0	5427.0	6686.4		
November		18878	6110.0	8100.0	8526.0		
December		32727	7902.0	15013.0	13749.0		
January		23312	8728.0	13200.0	13156.8		
February		19822	7217.0	7508.0	8835.0		
March		17981	7181.0	6177.0	8014.8		
April		15081	6915.0	8397.0	9187.2		
May		11855	5940.0	7333.0	7963.8		
June		10515	4475.0	6303.0	6466.8		
July		9240	4030.0	5190.0	5532.0		
August		7661	3883.0	4783.0	5199.6		
September		9159	4192.0	5001.0	5515.8		
Fuel energy, based on steam production, 1990 (MBtu):							
October		12396.1	5124.6	4864.7	5993.6		
November		16376.1	5300.2	7026.5	7396.0		
December		29336.0	7083.2	13457.4	12324.4		
January		20896.5	7823.7	11832.2	11793.6		
February		16048.7	5843.2	6078.8	7153.2		
March		16117.9	6436.9	5537.0	7184.4		

* = estimated

Table 38 (Cont'd)

Fuel	Units	Btu/Unit	$/Unit	1989 Use	1990 Use	$/MBtu	MBtu '90
Fuel energy, based on steam production, 1990 (MBtu) (cont'd):							
April		13082.3	5998.6	7284.1	7969.6		
May		10626.7	5324.5	6573.2	7138.6		
June		9121.4	3881.9	5467.7	5609.8		
July		8282.6	3612.4	4652.2	4958.8		
August		6867.2	3480.7	4287.4	4660.8		
September		7945.2	3636.4	4338.2	4784.8		
Total		167096.7	63546.4	81399.5	86967.6		399010.2
Percent of total		41.9	15.9	20.4	21.8		
Reserve fuel		#2	#2	#2	#2		
Fuel use (MBtu/year):							Total
Natural Gas		155399.9	59098.2	75701.6	80879.8		371080
Dist. Oil		11696.8	4448.2	5698.0	6087.7		27931
Res. Oil		0.0	0.0	0.0	0.0		0
Total $/yr:		1900523	634790.6	864295.3	858401.2	0	
$/MBtu:							
Labor		2.30	1.93	2.06	1.93		
Utilities		1.42	0.98	1.16	0.93		
Service		0.28	0.20	0.23	0.19		
Supplies		1.92	1.44	1.72	1.38		
Fuel		4.14	4.14	4.14	4.14		Average
Total $/MBtu		10.06	8.68	9.31	8.56		7.32
Reported $/MBtu:							

* = estimated

Table 39a

Boiler Evaluation Parts List—Fort Gordon Bldg. 25330

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1975	2	35	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			150	psig	365	temp	Good
2. Relief Valve(s)	1988	2	1.5	in.	250	psig	Good
2. Relief Valve(s)	1988	2	2	in.	255	psig	Good
3. Feedwater Regulator(s)	1975	2	2	in.	200	psig	Good
4. Boiler Burner(s)	1975	2	35	MBtu			Good
5. Boiler Fan(s) (FD)	1975	2	15	Hp			Good
7. Boiler Drum Level Control	1975	2					Good
B. Feedwater System							
8. Deaerating Heater	1975	1	______	lb/hr	40	gal/min	
12. Condensate Pumps	1975	2	20	Hp			Good
13. Condensate Receiver	1975	1	175	gal			Good
15. Make-up Pumps	1975	2	20	Hp			Good
18. Expansion Tank (CASCADES)	1975	2	7	diam (in.)	12	length (ft)	Good
19. Feedwater Piping System (valve)	1975		2	diam (in.)	200	psig	Good
20. Cooling Water Pumps	1975	2	175	Hp			Good
21. HTW Distribution System Pumps	1975	2	100	Hp			Good
C. Fuel Handling System							
3. Fuel Oil Tank - Underground	1975	2	50000	gal			Good
4. Fuel Oil Pump	1975	2	______	gpm	5	Hp	
4. Fuel Oil Pump	1975	2	______	gpm	7.5	Hp	
5. Fuel Oil Heater	1975	1	______	gpm			
6. Fuel Oil Piping System (BLW)	1975		4	diam (in.)			Good
7. Natural Gas Piping System (BLW)	1975		6	diam (in.)			Good
D. Heat Recovery System							
1. Blowdown Flash Tank	1975	1	3.5	diam (ft)	6	height (ft)	Good
E. Air Pollution Control Systems and Emission Monitoring							
5. Stack	1975	1	4	diam (ft)	65	height (ft)	Good

Table 39a (Cont'd)

Equipment	Year Installed	Units	Specification 1		Specification 2		Condition
F. Combustion Controls							
1. Plant Master	1975	1	___				Good
2. Boiler Master	1975	2	___				Good
3. Flame Safeguard System	1975	2	___				Good
5. Additional Boiler Instrumentation/Indicators					O2 charted-part of master Stack Smoke Detector		Good
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	___	___	___	gal	___	Hp	
H. Make-up Water System							
9. Sodium Zeolite Softener	1975	2	___	gpm			
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1975	3	___	SCFM	10	Hp	
2. Air Dryer (REFR)	1975	1	55	SCFM			Good
3. Air Receiver	1975	1	200	gal			Good
K. Electrical System							
1. Transformer/TransPCB	___	___	___	KVA			
2. Switchgear -- Main Circuit Breaker	___	___	___	amps			
3. Motor Control Center/Starter	___	___	___	amps			
4. Emergency Generator	1975	1	165	KVA			Good
L. Physical Plant							
1. Building Siding, Roofing, Windows, and Doors	1975						Good
2. Building Concrete and Building Steel	1975						Good
3. Sump Pump (SUBMERGE/VERTICAL)	1975	2	___	gpm	1.5	Hp	Good
4. Building Lighting	1975						Good
Building Outside Dimensions	___	Ht (ft)	___	Lgth (ft)	___	Width (ft)	
Building Basement (Yes/No)	___						

Table 39b

Status Quo Life Cycle Cost Analysis for
Fort Gordon Building 25330

LIFE CYCLE COST ANALYSIS STUDY: TDGRD3
LCCID 1.065 DATE/TIME: 05-14-92 16:59:50
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 25330
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	23133.9	1.58	JUL93-JUL17
NATURAL GAS	416361.0	3.64	JUL93-JUL17
MAINT LABOR	167500.0	.00	JUL93-JUL17
MAINT SERV	18919.0	.00	JUL93-JUL17
MAINT SUPPLY	140000.0	.00	JUL93-JUL17
MAINT UTIL	94595.0	.00	JUL93-JUL17
STACK	18000.0	.00	JAN 15
DRUMCTL	10000.0	.00	JAN 95
FW_REG	1266.0	.00	JAN 15
F_FAN	17250.0	.00	JAN 15
RELVALVE	2492.0	.00	JAN 08
RELVALVE	2708.0	.00	JAN 08
WTBOILER	1575000.0	.00	JAN 15
WTBURNER	120000.0	.00	JAN 15
BOILMASTER	10000.0	.00	JAN 05
FLAMESAFE	20000.0	.00	JAN 05
PLANTMASTER	5000.0	.00	JAN 05
AIRCOMPRECIP	60000.0	.00	JAN 95
AIRDRYERREFR	12100.0	.00	JAN 90
AIRRECV	1100.0	.00	JAN 05
EMERGENCYGEN	172186.0	.00	JAN 05
CONDPUMP	14000.0	.00	JAN 95
CONDREC	7500.0	.00	JAN 05
COOLPUMP	22800.0	.00	JAN 95
DAIRHEATER	25000.0	.00	JAN 15
EXPTANK	49000.0	.00	JAN 15
FWPIPINGVAL	1167.0	.00	JAN 95
HTWPUMP	48000.0	.00	JAN 05
MUPUMP	14000.0	.00	JAN 95

Table 39b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:59:50
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 25330
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

HEATER	4000.0	.00	JAN 05
NAGPIPEBELOW	40.0	.00	JAN 00
OILPIPEBELOW	49.0	.00	JAN 00
PUMP	3000.0	.00	JAN 00
PUMP	5000.0	.00	JAN 00
TANKBELOW	114000.0	.00	JAN 05
FLASHTANK	1775.0	.00	JAN 00
SZSOFT	140000.0	.00	JAN 95
SUMPPUMPVERT	10000.0	.00	JAN 90

OTHER KEY INPUT DATA

LOCATION - GEORGIA CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	4.06	5698.0		JAN93-JAN18
NAT G	5.50	75702.0		JAN93-JAN18

Table 39b (Cont'd)

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LCCID  1.065                    DATE/TIME:  05-14-92  16:59:50
PROJECT NO., FY, & TITLE:        FY 1992     BUILDING 25330
INSTALLATION & LOCATION: FORT GORDON     GEORGIA
DESIGN FEATURE:
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER:
```

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
DISTILLATE OIL	398395.	
NATURAL GAS	9096[illegible]53.	
TOTAL ENERGY COSTS		9495258.
RECURRING M&R/CUSTODIAL COSTS		6132983.
MAJOR REPAIR/REPLACEMENT COSTS		1109354.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		16737600.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 39b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:59:50
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 25330
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	22132.	399699.	399493.	0.	0.
2	21175.	388067.	381925.	0.	0.
3	20196.	372035.	365129.	232360.	0.
4	19303.	355674.	349072.	0.	0.
5	18472.	342851.	333720.	0.	0.
6	17770.	332715.	319044.	0.	0.
7	17353.	334732.	305014.	0.	0.
8	17055.	342170.	291600.	6987.	0.
9	16810.	352606.	278776.	0.	0.
10	16638.	369274.	266517.	0.	0.
11	16464.	380813.	254796.	0.	0.
12	16267.	384732.	243591.	0.	0.
13	16059.	392984.	232878.	215983.	0.
14	15772.	397431.	222637.	0.	0.
15	15426.	399155.	212846.	0.	0.
16	15012.	394844.	203486.	2570.	0.
17	14558.	385176.	194537.	0.	0.
18	14057.	379995.	185982.	0.	0.
19	13616.	370598.	177803.	0.	0.
20	13261.	360955.	169984.	0.	0.
21	12930.	351940.	162508.	0.	0.
22	12577.	342319.	155362.	0.	0.
23	12221.	332637.	148529.	651453.	0.
24	11825.	321865.	141998.	0.	0.
25	11448.	311596.	135753.	0.	0.
***	398395.	9096863.	6132983.	1109354.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 40a

Boiler Evaluation Parts List—Fort Gordon Bldg. 25910

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1965	3	33.25	MBtu/hr			Good
A. Boiler (WT)	1967	2	34	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			170	psig	365	temp	Good
2. Relief Valve(s)	1988	5	2	in.	250	psig	Good
2. Relief Valve(s)	1988	5	2	in.	256	psig	Good
3. Feedwater Regulator(s)	1988	6	3	in.	250	psig	Good
4. Boiler Burner(s)	1965	3	45	MBtu			Good
4. Boiler Burner(s)	1967	2	45	MBtu			Good
5. Boiler Fan(s) (FD)	1965	3	20	Hp			Good
5. Boiler Fan(s) (FD)	1967	2	20	Hp			Good
5. Boiler Fan(s) (ID)	1965	3	20	Hp			Good
5. Boiler Fan(s) (ID)	1967	2	20	Hp			Good
6. Boiler Economizer	Out of Service						
7. Boiler Drum Level Control	1988	5					Good
B. Feedwater System							
8. Deaerating Heater	1991	1	______	lb/hr	40	gal/min	
15. Make-up Pumps	1985	1	7	Hp			Good
18. Expansion Tank (Cascades)	1965	3	387000	lb/hr			Good
19. Feedwater Piping System (valve)	1965		3	diam (in.)	250	psig	Good
20. Cooling Water Pumps	1965	4	300	Hp			Good
21. HTW Distribution System Pumps	1985	6	75	Hp			Good
C. Fuel Handling System							
3. Fuel Oil Tank - Underground	1965	8	50000	gal			Good
4. Fuel Oil Pump	1965	2	______	gpm			
4. Fuel Oil Pump	1965	2	______	gpm			
5. Fuel Oil Heater	1965	2	______	gpm			
6. Fuel Oil Piping System (BLW)	1965		2.5	diam (in.)			Good
7. Natural Gas Piping System (BLW)	1965		5	diam (in.)			Good
D. Heat Recovery System							
1. Blowdown Flash Tank	1965	1	3.5	diam (ft)	6	height (ft)	Good
E. Air Pollution Control Systems							
5. Stack	1982	1	4	diam (ft)	110	height (ft)	Good

Table 40a (Cont'd)

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
F. Combustion Controls							
1. Plant Master	1989	1					Good
2. Boiler Master	1989	5					Good
3. Flame Safeguard System	1965	3					Good
3. Flame Safeguard System	1967	2					Good
5. Additional Boiler Instrumentation/Indicators	1989			O2 TRIM - part of master			Good
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	___	___	___	gal	___	Hp	Good
H. Make-up Water System							
9. Sodium Zeolite Softener	1982	2	___	gpm			
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1979	2	___	SCFM	15	Hp	
1. Air Compressor (RECIP)	1979	1	___	SCFM	10	Hp	
2. Air Dryer (REFR)	1965	1	55	SCFM			Good
3. Air Receiver	1965	2	200	gal			Good
3. Air Receiver	1965	1	75	gal			Good
K. Electrical System							
1. Transformer/TransPCB	___	___	___	KVA			
2. Switchgear -- Main Circuit Breaker	___	___	___	amps			
3. Motor Control Center/Starter	___	___	___	amps			
4. Emergency Generator	1965	1	94	KVA			Good
L. Physical Plant							
1. Building Siding, Roofing, Windows, and Doors	1965						Good
2. Building Concrete and Building Steel	1965						Good
3. Sump Pump (SUBMERGE/VERTICAL)	1985	2	___	gpm	0.75	Hp	
4. Building Lighting	1965						Good
Building Outside Dimensions	___	Ht (ft)	___	Lgth (ft)	___	Width (ft)	
Building Basement (Yes/No)	___						

Table 40b

Status Quo Life Cycle Cost Analysis for
Fort Gordon Building 25910

LIFE CYCLE COST ANALYSIS STUDY: TDGRD1
LCCID 1.065 DATE/TIME: 05-15-92 09:11:14
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 25910
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	47489.8	1.58	JUL93-JUL17
NATURAL GAS	854700.0	3.64	JUL93-JUL17
MAINT LABOR	385000.0	.00	JUL93-JUL17
MAINT SERV	47446.0	.00	JUL93-JUL17
MAINT SUPPLY	320880.0	.00	JUL93-JUL17
MAINT UTIL	237230.0	.00	JUL93-JUL17
DRUMCTL	25000.0	.00	JAN 08
F_FAN	30750.0	.00	JAN 05
F_FAN	20500.0	.00	JAN 07
I_FAN	30750.0	.00	JAN 05
I_FAN	20500.0	.00	JAN 07
RELVALVE	6730.0	.00	JAN 08
RELVALVE	6775.0	.00	JAN 08
WTBOILER	2298750.0	.00	JAN 05
WTBOILER	1550000.0	.00	JAN 07
WTBURNER	210000.0	.00	JAN 05
WTBURNER	140000.0	.00	JAN 07
FLAMESAFE	30000.0	.00	JAN 95
FLAMESAFE	20000.0	.00	JAN 97
AIRCOMPRECIP	20000.0	.00	JAN 99
AIRCOMPRECIP	46000.0	.00	JAN 99
AIRDRYERREFR	12100.0	.00	JAN 95
AIRRECV	600.0	.00	JAN 95
AIRRECV	2200.0	.00	JAN 95
EMERGENCYGEN	35000.0	.00	JAN 95
COOLPUMP	45600.0	.00	JAN 95
EXPTANK	73500.0	.00	JAN 05
FWPIPINGVAL	1233.0	.00	JAN 95
HTWPUMP	138000.0	.00	JAN 15

Table 40b (Cont'd)

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LCCID  1.065                     DATE/TIME:  05-15-92  09:11:14
PROJECT NO., FY, & TITLE:      FY 1992    BUILDING 25910
INSTALLATION & LOCATION: FORT GORDON    GEORGIA
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:
```

BASIC INPUT DATA SUMMARY

MUPUMP	4900.0	.00	JAN 05
HEATER	5000.0	.00	JAN 95
NAGPIPEBELOW	32.0	.00	JAN 00
OILPIPEBELOW	31.0	.00	JAN 00
PUMP	3000.0	.00	JAN 00
PUMP	5000.0	.00	JAN 00
TANKBELOW	456000.0	.00	JAN 95
FLASHTANK	1775.0	.00	JAN 00
SZSOFT	410000.0	.00	JAN 02
SUMPPUMPVERT	9800.0	.00	JAN 00

OTHER KEY INPUT DATA

```
LOCATION   - GEORGIA                CENSUS REGION:  3
RATES FOR INDUSTRIAL  SECTOR.  TABLES FROM OCT 91
```

ENERGY USAGE: 10**6 BTUS   ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	4.06	11697.0		JAN93-JAN18
NAT G	5.50	155400.0		JAN93-JAN18

LCCID 1.065 DATE/TIME: 05-15-92 09:11:14
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 25910
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
DISTILLATE OIL	817834.	
NATURAL GAS	18673910.	
TOTAL ENERGY COSTS		19491750.
RECURRING M&R/CUSTODIAL COSTS		14429600.
MAJOR REPAIR/REPLACEMENT COSTS		3328013.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		37249360.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 40b (Cont'd)

LCCID 1.065 DATE/TIME: 05-15-92 09:11:14
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 25910
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	45433.	820496.	939923.	0.	0.
2	43469.	796618.	898588.	0.	0.
3	41458.	763707.	859070.	521309.	0.
4	39626.	730122.	821291.	0.	0.
5	37919.	703799.	785173.	16214.	0.
6	36479.	682992.	750643.	0.	0.
7	35622.	687134.	717632.	48903.	0.
8	35011.	702403.	686073.	13911.	0.
9	34508.	723826.	655902.	0.	0.
10	34154.	758040.	627057.	265447.	0.
11	33797.	781727.	599481.	0.	0.
12	33393.	789773.	573117.	0.	0.
13	32966.	806713.	547913.	1498384.	0.
14	32376.	815840.	523818.	0.	0.
15	31667.	819379.	500782.	895019.	0.
16	30817.	810531.	478759.	19034.	0.
17	29884.	790683.	457704.	0.	0.
18	28856.	780049.	437576.	0.	0.
19	27951.	760759.	418333.	0.	0.
20	27223.	740964.	399936.	0.	0.
21	26543.	722457.	382348.	0.	0.
22	25818.	702708.	365533.	0.	0.
23	25088.	682833.	349458.	49792.	0.
24	24275.	660721.	334090.	0.	0.
25	23501.	639640.	319398.	0.	0.
***	817834.	********	********	3328013.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 41a

Boiler Evaluation Parts List—Fort Gordon Bldg. 2202

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1972	2	30	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			125	psig	344	temp	Good
2. Relief Valve(s)	1972	2	2.5	in.	140	psig	Good
2. Relief Valve(s)	1972	2	2.5	in.	155	psig	Good
3. Feedwater Regulator(s)	1972	2	2	in.	125	psig	Good
4. Boiler Burner(s)	1972	2	38.97	MBtu			Good
5. Boiler Fan(s) (FD)	1972	2	20	Hp			Good
6. Boiler Economizer	1972	2	______	MBtu	30	lb/hr	
7. Boiler Drum Level Control	1972	2					Good
B. Feedwater System							
8. Deaerating Heater	1972	1	______	lb/hr			
12. Condensate Pumps	1972	1	1.5	Hp			Good
13. Condensate Receiver	1972	1	25	gal			Good
15. Make-up Pumps	1972	2	20	Hp			Good
19. Feedwater Piping System (valve)	1972		2	diam (in.)	125	psig	Good
C. Fuel Handling System							
3. Fuel Oil Tank - Underground	1972	2	30000	gal			Good
4. Fuel Oil Pump	1972	1	______	gpm	2	Hp	
5. Fuel Oil Heater	1972	1	______	gpm			
6. Fuel Oil Piping System (BLW)	1972		2	diam (in.)			Good
7. Natural Gas Piping System (BLW)	1972		2.5	diam (in.)			Good
D. Heat Recovery System							
1. Blowdown Flash Tank	1972	1	3.5	diam (ft)	6	height (ft)	Good
E. Air Pollution Control Systems and Emissions Monitoring							
5. Stack	1972	2	2.5	diam (ft)	60	height (ft)	Good
F. Combustion Controls							
1. Plant Master	1972	1					Good
2. Boiler Master	1972	2					Good
3. Flame Safeguard System	1972	2					Good
5. Additional Boiler Instrumentation/Indicators				O2 chart			Good
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	______	______	______	gal	______	Hp	
H. Make-up Water System							
9. Sodium Zeolite Softener	1991	1	______	gpm			

Table 41a (Cont'd)

Equipment	Year Installed	Units	Specification 1		Specification 2		Condition
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1972	1	____	SCFM	1	Hp	
2. Air Dryer (REFR)	1972	1	35	SCFM			Good
3. Air Receiver	1972	1	10	gal			Good
K. Electrical System							
1. Transformer/TransPCB	____	____	____	KVA			
2. Switchgear -- Main Circuit Breaker	____	____	____	amps			
3. Motor Control Center/Starter	____	____	____	amps			
L. Physical Plant							
1. Building Siding, Roofing, Windows, and Doors	1972						Good
2. Building Concrete and Building Steel	1972						Good
4. Building Lighting	1972						Good
Building Outside Dimensions	____	Ht (ft)	____	Lgth (ft)	____	Width (ft)	
Building Basement (Yes/No)	____						

Table 41b

Status Quo Life Cycle Cost Analysis for Fort Gordon Building 2202

```
      LIFE CYCLE COST ANALYSIS                          STUDY: TDGRD4
LCCID  1.065                    DATE/TIME:  05-14-92  17:03:58
PROJECT NO., FY, & TITLE:        FY 1992     BUILDING 2202
INSTALLATION & LOCATION: FORT GORDON    GEORGIA
DESIGN FEATURE:
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER:
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	24717.3	1.58	JUL93-JUL17
NATURAL GAS	444840.0	3.64	JUL93-JUL17
MAINT LABOR	167500.0	.00	JUL93-JUL17
MAINT SERV	16216.0	.00	JUL93-JUL17
MAINT SUPPLY	120000.0	.00	JUL93-JUL17
MAINT UTIL	81081.0	.00	JUL93-JUL17
STACK	29000.0	.00	JAN 12
DRUMCTL	10000.0	.00	JAN 92
ECONOMIZER	140000.0	.00	JAN 92
FW_REG	1200.0	.00	JAN 12
F_FAN	20500.0	.00	JAN 12
RELVALVE	3044.0	.00	JAN 92
RELVALVE	1545.0	.00	JAN 92
WTBOILER	1450000.0	.00	JAN 12
WTBURNER	128000.0	.00	JAN 12
BOILMASTER	10000.0	.00	JAN 02
FLAMESAFE	20000.0	.00	JAN 02
PLANTMASTER	5000.0	.00	JAN 02
AIRCOMPRECIP	20000.0	.00	JAN 92
AIRDRYERREFR	12000.0	.00	JAN 87
AIRRECV	600.0	.00	JAN 02
CONDPUMP	3625.0	.00	JAN 92
CONDREC	6000.0	.00	JAN 02
DAIRHEATER	25000.0	.00	JAN 12
FWPIPINGVAL	1100.0	.00	JAN 92
MUPUMP	14000.0	.00	JAN 92
HEATER	2500.0	.00	JAN 02
NAGPIPEBELOW	16.0	.00	JAN 97
OILPIPEBELOW	25.0	.00	JAN 97

LCCID 1.065 DATE/TIME: 05-14-92 17:03:58
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 2202
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

PUMP	1300.0	.00	JAN 97
TANKBELOW	84000.0	.00	JAN 02
FLASHTANK	1775.0	.00	JAN 97
SZSOFT	135000.0	.00	JAN 11

OTHER KEY INPUT DATA

LOCATION - GEORGIA CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	4.06	6088.0		JAN93-JAN18
NAT G	5.50	80880.0		JAN93-JAN18

LCCID 1.065 DATE/TIME: 05-14-92 17:03:58
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 2202
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
DISTILLATE OIL	425663.	
NATURAL GAS	9719086.	
TOTAL ENERGY COSTS		10144750.
RECURRING M&R/CUSTODIAL COSTS		5605403.
MAJOR REPAIR/REPLACEMENT COSTS		826635.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		16576790.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

LCCID 1.065 DATE/TIME: 05-14-92 17:03:58
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 2202
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	23647.	427038.	365128.	0.	0.
2	22624.	414611.	349070.	0.	0.
3	21578.	397482.	333719.	0.	0.
4	20624.	380002.	319043.	0.	0.
5	19736.	366302.	305013.	2526.	0.
6	18986.	355472.	291599.	0.	0.
7	18540.	357628.	278776.	0.	0.
8	18222.	365575.	266516.	0.	0.
9	17960.	376725.	254795.	0.	0.
10	17777.	394532.	243590.	82936.	0.
11	17591.	406860.	232878.	0.	0.
12	17380.	411048.	222636.	0.	0.
13	17158.	419864.	212846.	0.	0.
14	16851.	424615.	203485.	0.	0.
15	16482.	426457.	194537.	0.	0.
16	16039.	421851.	185981.	0.	0.
17	15554.	411522.	177802.	0.	0.
18	15019.	405987.	169983.	0.	0.
19	14548.	395947.	162508.	58310.	0.
20	14169.	385645.	155361.	682863.	0.
21	13815.	376013.	148529.	0.	0.
22	13438.	365734.	141997.	0.	0.
23	13057.	355389.	135752.	0.	0.
24	12635.	343881.	129782.	0.	0.
25	12232.	332909.	124075.	0.	0.
***	425663.	9719086.	5605403.	826635.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 42a

Boiler Evaluation Parts List--Fort Gordon Bldg. 310

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1972	3	18	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			75	psig	308	temp	Good
2. Relief Valve(s)	1988	3	1.5	in.	140	psig	Good
2. Relief Valve(s)	1988	3	1.5	in.	150	psig	Good
3. Feedwater Regulator(s)	1972	3	2	in.	120	psig	Good
4. Boiler Burner(s)	1972	3	20	MBtu			Good
5. Boiler Fan(s) (FD)	1972	3	10	Hp			Good
5. Boiler Fan(s) (ID)	1972	3	10	Hp			Good
6. Boiler Economizer	1982	3	______	MBtu			
7. Boiler Drum Level Control	1987	3					Good
B. Feedwater System							
8. Deaerating Heater	1972	1	______	lb/hr			
12. Condensate Pumps	1972	2	7	Hp			Good
13. Condensate Receiver	1972	1	35	gal			Good
15. Make-up Pumps	1972	4	15	Hp			Good
18. Expansion Tank (SURGE Tank)	1972	1	4	diam (in.)	8	length (ft)	Good
19. *Feedwater Piping System* (valve)	1972		2	diam (in.)	120	psig	Good
20. Cooling Water Pumps	1972	2	100	Hp			Good
20. Cooling Water Pumps	1972	1	30	Hp			Good
20. Cooling Water Pumps	1972	1	20	Hp			Good
C. Fuel Handling System							
3. Fuel Oil Tank - Underground	1972	1	200000	gal			Good
3. Fuel Oil Tank - Underground	1972	1	30000	gal			Good
3. Fuel Oil Tank - Underground	1972	1	20000	gal			Good
4. Fuel Oil Pump	1972	2	______	gpm	2	Hp	
6. Fuel Oil Piping System (BLW)	1972		1.5	diam (in.)			Good
7. Natural Gas Piping System (BLW)	1972		4	diam (in.)			Good
D. Heat Recovery System							
1. Blowdown Flash Tank	1972	1	3.5	diam (ft)	6	height (ft)	Good
E. Air Pollution Control Systems and Emissions Monitoring							Good
5. Stack	1972	3	2.5	diam (ft)	43	height (ft)	Good

Table 42a (Cont'd)

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
F. Combustion Controls							Good
1. Plant Master	1987	1					Fair
2. Boiler Master	1987	3					Fair
3. Flame Safeguard System	1987	3					Fair
5. Additional Boiler Instrumentation/Indicators				O2 TRIM - Disconnected			
G. Chemical Feed System							
H. Make-up Water System							
9. Sodium Zeolite Softener	1987	2	______	gpm			
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1972	2	______	SCFM	5	Hp	Good
2. Air Dryer (REFR)	1972	1	15	SCFM			Good
3. Air Receiver	1972	1	150	gal			Good
K. Electrical System							
1. Transformer	1972	1	2000	KVA			Good
2. 'Switchgear -- Main Circuit Breaker	______	______	______	amps			
3. Motor Control Center/Starter	______	______	______	amps			
4. Emergency Generator	1972	1	3125	KVA			Good
L. Physical Plant							
1. Building Siding, Roofing, Windows, and Doors	1972						Good
2. Building Concrete and Building Steel	1972						Good
4. Building Lighting	1972						Good
Building Outside Dimensions	______	Ht (ft)	______	Lgth (ft)	______	Width (ft)	
Building Basement (Yes/No)	______						

Table 42b

Status Quo Life Cycle Cost Analysis for
Fort Gordon Building 310

```
      LIFE CYCLE COST ANALYSIS                        STUDY: TDGRD2
LCCID  1.065                   DATE/TIME:  05-14-92  16:57:15
PROJECT NO., FY, & TITLE:       FY 1992    BUILDING 310
INSTALLATION & LOCATION: FORT GORDON    GEORGIA
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:
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BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	18058.9	1.58	JUL93-JUL17
NATURAL GAS	325039.0	3.64	JUL93-JUL17
MAINT LABOR	122500.0	.00	JUL93-JUL17
MAINT SERV	12405.0	.00	JUL93-JUL17
MAINT SUPPLY	91800.0	.00	JUL93-JUL17
MAINT UTIL	62027.0	.00	JUL93-JUL17
STACK	30000.0	.00	JAN 12
DRUMCTL	15000.0	.00	JAN 07
ECONOMIZER	210000.0	.00	JAN 02
FW_REG	1800.0	.00	JAN 12
F_FAN	21000.0	.00	JAN 12
I_FAN	21000.0	.00	JAN 12
RELVALVE	3216.0	.00	JAN 08
RELVALVE	5100.0	.00	JAN 08
WTBOILER	1800000.0	.00	JAN 12
WTBURNER	150000.0	.00	JAN 12
BOILMASTER	15000.0	.00	JAN 17
FLAMESAFE	30000.0	.00	JAN 17
O2TRIM	30000.0	.00	JAN 17
PLANTMASTER	5000.0	.00	JAN 17
AIRCOMPRECIP	40000.0	.00	JAN 92
AIRDRYERREFR	12000.0	.00	JAN 87
AIRRECV	850.0	.00	JAN 02
EMERGENCYGEN	210000.0	.00	JAN 02
TRANSFORMER	44000.0	.00	JAN 12
CONDPUMP	9800.0	.00	JAN 92
CONDREC	6000.0	.00	JAN 02
COOLPUMP	7000.0	.00	JAN 92
COOLPUMP	8200.0	.00	JAN 92

Table 42b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:57:15
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 310
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

COOLPUMP	22800.0	.00	JAN 92
DAIRHEATER	25000.0	.00	JAN 12
EXPTANK	10000.0	.00	JAN 12
FWPIPINGVAL	1100.0	.00	JAN 92
MUPUMP	25000.0	.00	JAN 92
NAGPIPEBELOW	23.0	.00	JAN 97
OILPIPEBELOW	25.0	.00	JAN 97
PUMP	2600.0	.00	JAN 97
TANKBELOW	26000.0	.00	JAN 02
TANKBELOW	42000.0	.00	JAN 02
TANKBELOW	57000.0	.00	JAN 02
FLASHTANK	1775.0	.00	JAN 97
SZSOFT	316666.0	.00	JAN 07

OTHER KEY INPUT DATA

LOCATION - GEORGIA CENSUS REGION: 3
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	4.06	4448.0		JAN93-JAN18
NAT G	5.50	59098.0		JAN93-JAN18

Table 42b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:57:15
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 310
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS		0.
ENERGY COSTS:		
DISTILLATE OIL	310997.	
NATURAL GAS	7101614.	
TOTAL ENERGY COSTS		7412610.
RECURRING M&R/CUSTODIAL COSTS		4206008.
MAJOR REPAIR/REPLACEMENT COSTS		1431163.
OTHER O&M COSTS & MONETARY BENEFITS		0.
DISPOSAL COSTS/RETENTION VALUE		0.
LCC OF ALL COSTS/BENEFITS (NET PW)		13049780.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 42b (Cont'd)

LCCID 1.065 DATE/TIME: 05-14-92 16:57:15
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 310
INSTALLATION & LOCATION: FORT GORDON GEORGIA
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	NAT G	M & R	R / R	OTHER
1	17277.	312031.	273973.	0.	0.
2	16530.	302951.	261925.	0.	0.
3	15765.	290435.	250406.	0.	0.
4	15069.	277662.	239394.	0.	0.
5	14420.	267652.	228866.	3586.	0.
6	13872.	259739.	218801.	0.	0.
7	13546.	261314.	209179.	0.	0.
8	13314.	267121.	199980.	0.	0.
9	13122.	275268.	191185.	0.	0.
10	12988.	288280.	182778.	357285.	0.
11	12852.	297288.	174740.	0.	0.
12	12698.	300347.	167055.	0.	0.
13	12536.	306790.	159708.	0.	0.
14	12312.	310261.	152685.	0.	0.
15	12042.	311607.	145970.	171489.	0.
16	11719.	308242.	139551.	4111.	0.
17	11364.	300694.	133414.	0.	0.
18	10973.	296650.	127547.	0.	0.
19	10629.	289314.	121938.	0.	0.
20	10352.	281786.	116575.	868310.	0.
21	10094.	274748.	111449.	0.	0.
22	9818.	267237.	106547.	0.	0.
23	9540.	259678.	101862.	0.	0.
24	9231.	251269.	97382.	0.	0.
25	8937.	243253.	93100.	26382.	0.
***	310997.	7101614.	4206008.	1431163.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 43

CHPECON Run Results for Fort Gordon Bldg. 25330

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
GAS	24/24/24	16.583	19.826	4498	37779	49672	100
#2 OIL	24/24/24	12.867	15.384	4498	26650	38543	78
#6 OIL	24/24/24	10.330	12.350	4498	19049	30942	62
STOKER	16/28/28/28	22.824	27.289	35846	10360	68368	138
CWS	14/28/35/35	18.869	22.559	24739	14323	59062	119
COM	17/29/29/29	18.556	22.186	21252	17932	58085	117
FBC	13/26/33/33	23.106	27.625	33669	12729	69211	139

FILE PREFIX: FGD1
PMCR: 70 L
AVE MON. LOAD: 23 M
CHP #1 2@ 35 L FUEL = NG,FS2 AGE = 1975
L = (K# STEAM/HR)
M = (MBTU/HR)

Table 44

CHPECON Run Results for Fort Gordon Bldg. 25910

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
GAS	59/59/59	14.574	17.425	6890	96487	111986	100
#2 OIL	59/59/59	9.875	11.806	6890	60379	75877	68
#6 OIL	59/59/59	8.322	9.950	6890	48444	63942	57
STOKER	40/69/69/69	13.204	15.787	48926	24030	101461	91
CWS	35/69/88/88	12.368	14.788	39405	35329	99314	89
COM	42/72/72/72	12.071	14.432	30081	44823	96923	87
FBC	32/64/81/81	14.250	17.037	47540	31837	109495	98

FILE PREFIX: FGD2
PMCR: 176 L
AVE MON. LOAD: 59 M
CHP #2 3@ 35.9 L FUEL = NG,FS AGE = 1965
3@ 34 L FUEL = NG,FS AGE = 1967
L=(K# STEAM/HR)
M=(MBTU/HR)

Table 45

CHPECON Run Results for Fort Gordon Bldg. 2202

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
GAS	20/20/20	17.082	20.424	4300	32891	44494	100
#2 OIL	20/20/20	12.383	14.805	4300	20651	32253	72
#6 OIL	20/20/20	10.829	12.948	4300	16605	28207	63
STOKER	14/24/24/24	25.071	29.975	34817	9059	65302	147
CWS	12/24/30/30	20.493	24.502	23517	12607	55780	125
COM	15/25/25/25	20.118	24.053	20307	15791	54759	123
FBC	11/22/28/28	25.192	30.119	32522	11122	65616	147

FILE PREFIX: FGD3
PMCR: 60 L
AVE MON. LOAD: 20 M
CHP #3 2@ 30 L FUEL = NG,FS2 AGE = 1972
L=(K# STEAM/HR)
M=(MBTU/HR)

Table 46

Cost Sensitivity Analysis for New Gas/#2 Oil-Fired Boiler Plant

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 1
File: FGDG   Type: New plant (NP)   05/13/92
Desc: FORT GORDON
Tech: Gas / Oil Fired Boiler

****
Base and Plant Information
****

State: GA - Georgia   Base DOE Region: 3
PMCR: 100,000 lb/hr steam   Number of boilers: 3

Height of the plant: 40 ft
Building area: 6500 sq ft
Plant area: 1.13 acres

****
Facility Parameters
****

Capital Equipment Escalation Factor: 1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor: 1.106 (947.10/1991)
Operation & Maintenance Labor Escalation Factor: 1.061 (4386.55/1991)
Construction Labor Escalation Factor: 1.030 (272.70/1991)

Annual electricity usage: 730,093 kW-hr

1991 cost for distillate: 0.631 $/gallon
1991 cost for residual: 0.400 $/gallon
1991 cost for natural gas: 2.722 $/million Btu
1991 cost for electricity: 0.053 $/kW-hr

Annual Facility Output: 257,664 thousand lb steam
Annual Natural Gas Usage: 316 10^6 SCF
Heating plant efficiency: 83.2% natural gas
Year of Study: 1991
Years of Operation: 1995 - 2019

****
Facility Capital Costs
****

Equipment		Cost	Equipment		Cost
Boiler:	$	1,010,599	Stack:	$	32,911
Building/service:	$	949,121	Water trtmnt:	$	408,948
Feedwtr pmps:	$	17,211	Cond xfr pmps:	$	14,703
Cond strg tnk:	$	5,489	Oil (long) storage:	$	183,313
Oil day strg pmp:	$	4,388	Oil heaters:	$	4,962
Oil day strg tanks:	$	14,929	Oil unload pumps:	$	13,791
Oil xfr pmps:	$	4,544	Fire protection:	$	41,792
Cont bldn tnk:	$	783	Intr bldn tnk:	$	783
Compressor:	$	24,453	Car puller:	$	20,896
Rail:	$	11,101	Site preparation:	$	2,951
Site improvements:	$	156,723	Mobile equipment:	$	40,748
Elec substation:	$	56,990	Electrical:	$	121,787
Piping:	$	690,129	Instrumentation:	$	255,174
Direct costs:	$	1,478,264			

Table 46 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 2
File: FGDG Type: New plant (NP) 05/13/92
Desc: FORT GORDON
Tech: Gas / Oil Fired Boiler

****
Facility Capital Costs, cont
****

Plant installed cost: $ 5,899,197

****
Facility Annual O & M and Energy Costs
****

Operating staff: 11
Annual Labor Costs: $ 463,732
Annual Year Non-Labor O & M Costs : $ 564,338
1995 Natural gas costs : $ 1,111,374
1995 Auxiliary Energy Costs : $ 38,781

****
Periodic Major Maintenance Cost Summary
****

Time Interval	Cost	Time Interval	Cost
3 years	$ 30,000	5 years	$ 5,920
10 years	$ 159,115	15 years	$ 67,520
18 years	$ 5,881	20 years	$ 12,754

****
Facility Life Cycle Cost Summary
****

Analysis using natural gas as primary fuel

+ PV 'Adjusted' Investment Costs	= $ 5,169,447
+ PV Energy + Transportation Costs	= $ 23,950,742
+ PV Annually Recurring O&M Costs	= $ 7,319,586
+ PV Non-Annually Recurring Repair & Replacement	= $ 320,675
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 36,760,450

Levelized Cost of Service (1995 start) = 9.5966 $/MMBtu
Levelized Cost of Service (1995 start) = 11.473 $/1000 lb steam

****
Sensitivity Analysis
****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	11,703,494	25,056,955	7.820
60%	14,044,193	27,397,654	8.551

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 3
File: FGDG   Type: New plant (NP)   05/13/92
Desc: FORT GORDON
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

80%	18,725,591	32,079,052	10.012
90%	21,066,290	34,419,751	10.743
100%	23,406,989	36,760,450	11.473
110%	25,747,688	39,101,149	12.204
120%	28,088,387	41,441,848	12.934
130%	30,429,086	43,782,547	13.665
140%	32,769,785	46,123,246	14.396
150%	35,110,484	48,463,945	15.126

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	16,316,909	29,670,370	9.260
-2%	18,333,295	31,686,756	9.890
-1%	20,676,900	34,030,361	10.621
0%	23,406,989	36,760,450	11.473
1%	26,593,946	39,947,408	12.468
2%	30,321,368	43,674,829	13.631
3%	34,688,529	48,041,991	14.994
4%	39,813,314	53,166,775	16.594
5%	45,835,664	59,189,125	18.474
6%	52,921,668	66,275,129	20.685

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	435,002	36,651,700	11.439
90%	489,377	36,706,075	11.456
100%	543,752	36,760,450	11.473
110%	598,127	36,814,825	11.490
120%	652,503	36,869,201	11.507

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	4,820,558	35,555,310	11.097
90%	5,423,128	36,157,880	11.285
100%	6,025,698	36,760,450	11.473
110%	6,628,268	37,363,020	11.661
120%	7,230,838	37,965,590	11.849

=== O&M non-labor cost variation ===

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	1,035,109	36,501,673	11.392
90%	1,164,498	36,631,061	11.433
100%	1,293,887	36,760,450	11.473
110%	1,423,276	36,889,839	11.514

Table 46 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 4
File: FGDG   Type: New plant (NP)   05/13/92
Desc: FORT GORDON
Tech: Gas / Oil Fired Boiler

****
Sensitivity Analysis, cont
****

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	256,540	36,696,315	11.453
90%	288,607	36,728,383	11.463
100%	320,675	36,760,450	11.473
110%	352,742	36,792,518	11.483
120%	384,810	36,824,585	11.493

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	4,135,557	35,583,743	11.106
90%	4,652,502	36,172,097	11.290
100%	5,169,447	36,760,450	11.473
110%	5,686,391	37,348,804	11.657
120%	6,203,336	37,937,157	11.840

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-149,970	36,910,421	11.520
-10%	-99,980	36,860,431	11.504
-5%	-49,990	36,810,440	11.489
0%	0	36,760,450	11.473
5%	49,990	36,710,460	11.458
10%	99,980	36,660,470	11.442
15%	149,970	36,610,479	11.426

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	70,455,438	21.990
0.5%	65,060,408	20.306
1.5%	55,793,510	17.414
2.5%	48,203,139	15.045
3.5%	41,947,628	13.092
4.5%	36,760,450	11.473
5.5%	32,432,735	10.122
6.5%	28,800,038	8.989
7.5%	25,732,296	8.031
8.5%	23,126,163	7.218

Table 46 (Cont'd)

****
Sensitivity Analysis, cont
****

10.5%	18,985,100	5.925
11.5%	17,330,735	5.409
12.0%	16,587,122	5.177

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	19,252,357	11.260
11 yr	20,573,828	11.164
12 yr	21,905,503	11.118
13 yr	23,222,908	11.100
14 yr	24,525,950	11.103
15 yr	25,856,367	11.142
16 yr	27,103,773	11.166
17 yr	28,310,518	11.191
18 yr	29,494,525	11.225
19 yr	30,628,265	11.256
20 yr	31,791,512	11.311
21 yr	32,862,038	11.346
22 yr	33,884,866	11.377
23 yr	34,873,673	11.408
24 yr	35,836,717	11.442
25 yr	36,760,450	11.473

Table 47

Cost Sensitivity Analysis for #6 Oil-Fired Boiler Plant

```
Central Heating Plant Economics Evaluation -- Sensitivity Analysis      Page 1
File: FGD6          Type: New plant (NP)                              05/13/92
Desc: FORT GORDON
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Base and Plant Information
*******************************************************************************

State: GA - Georgia                    Base DOE Region: 3
PMCR: 100,000 lb/hr steam          Number of boilers: 3

Height of the plant: 40 ft
Building area: 6500 sq ft
Plant area: 1.13 acres

*******************************************************************************
   Facility Parameters
*******************************************************************************

Capital Equipment Escalation Factor:  1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor:  1.106 ( 947.10/1991)
Operation & Maintenance Labor Escalation Factor:  1.061 (4386.55/1991)
Construction Labor Escalation Factor:  1.030 ( 272.70/1991)

Annual electricity usage: 730,093 kW-hr

1991 cost for distillate:  0.631 $/gallon
1991 cost for residual:  0.400 $/gallon
1991 cost for natural gas:  2.722 $/million Btu
1991 cost for electricity:  0.053 $/kW-hr

Annual Facility Output: 257,664 thousand lb steam
Annual #6 Fuel Oil Usage: 2,256 10^3 gal
Heating plant efficiency: 87.8% #6 fuel oil
Year of Study: 1991
Years of Operation: 1995 - 2019

*******************************************************************************
   Facility Capital Costs
*******************************************************************************
```

Equipment		Cost	Equipment		Cost
Boiler:	$	1,010,599	Stack:	$	32,911
Building/service:	$	949,121	Water trtmnt:	$	408,948
Feedwtr pmps:	$	17,211	Cond xfr pmps:	$	14,703
Cond strg tnk:	$	5,489	Oil (long) storage:	$	183,313
Oil day strg pmp:	$	4,388	Oil heaters:	$	4,962
Oil day strg tanks:	$	14,929	Oil unload pumps:	$	13,791
Oil xfr pmps:	$	4,544	Fire protection:	$	41,792
Cont bldn tnk:	$	783	Intr bldn tnk:	$	783
Compressor:	$	24,453	Car puller:	$	20,896
Rail:	$	11,101	Site preparation:	$	2,951
Site improvements:	$	156,723	Mobile equipment:	$	40,748
Elec substation:	$	56,990	Electrical:	$	121,787
Piping:	$	690,129	Instrumentation:	$	255,174
Direct costs:	$	1,478,264			

Table 47 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 2
File: FGD6 Type: New plant (NP) 05/13/92
Desc: FORT GORDON
Tech: Gas / Oil Fired Boiler

Facility Capital Costs, cont

Plant installed cost: $ 5,899,197

Facility Annual O & M and Energy Costs

Operating staff: 11
Annual Labor Costs: $ 463,732
Annual Year Non-Labor O & M Costs : $ 564,338
1995 #6 fuel oil costs : $ 1,213,004
1995 Auxiliary Energy Costs : $ 38,781

Periodic Major Maintenance Cost Summary

Time Interval	Cost	Time Interval	Cost
3 years	$ 30,000	5 years	$ 5 920
10 years	$ 159,115	15 years	$ 67,520
18 years	$ 5,881	20 years	$ 12,754

Facility Life Cycle Cost Summary

Analysis using #6 fuel oil as primary fuel

+ PV 'Adjusted' Investment Costs	= $ 5,169,447
+ PV Energy + Transportation Costs	= $ 24,325,649
+ PV Annually Recurring O&M Costs	= $ 7,319,586
+ PV Non-Annually Recurring Repair & Replacement	= $ 320,675
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 37,135,358

Levelized Cost of Service (1995 start) = 9.6944 $/MMBtu
Levelized Cost of Service (1995 start) = 11.590 $/1000 lb steam

Sensitivity Analysis

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	11,890,948	25,244,409	7.879
60%	14,269,138	27,622,599	8.621

Table 47 (Cont'd)

Desc: FORT GORDON
Tech: Gas / Oil Fired Boiler

****
Sensitivity Analysis, cont
****

80%	19,025,517	32,378,978	10.106
90%	21,403,707	34,757,168	10.848
100%	23,781,897	37,135,358	11.590
110%	26,160,086	39,513,547	12.333
120%	28,538,276	41,891,737	13.075
130%	30,916,466	44,269,927	13.817
140%	33,294,655	46,648,117	14.559
150%	35,672,845	49,026,306	15.302

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	16,835,067	30,188,528	9.422
-2%	18,818,531	32,171,992	10.041
-1%	21,115,443	34,468,904	10.758
0%	23,781,897	37,135,358	11.590
1%	26,884,461	40,237,922	12.559
2%	30,502,138	43,855,599	13.688
3%	34,728,690	48,082,151	15.007
4%	39,675,381	53,028,842	16.551
5%	45,474,228	58,827,690	18.361
6%	52,281,834	65,635,295	20.486

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	435,002	37,026,607	11.556
90%	489,377	37,080,982	11.573
100%	543,752	37,135,358	11.590
110%	598,127	37,189,733	11.607
120%	652,503	37,244,108	11.624

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	4,820,558	35,930,218	11.214
90%	5,423,128	36,532,788	11.402
100%	6,025,698	37,135,358	11.590
110%	6,628,268	37,737,928	11.778
120%	7,230,838	38,340,498	11.966

=== O&M non-labor cost variation ===

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	1,035,109	36,876,580	11.509
90%	1,164,498	37,005,969	11.550
100%	1,293,887	37,135,358	11.590
110%	1,423,276	37,264,746	11.631

Table 47 (Cont'd)

Desc: FORT GORDON
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	256,540	37,071,223	11.570
90%	288,607	37,103,290	11.580
100%	320,675	37,135,358	11.590
110%	352,742	37,167,425	11.600
120%	384,810	37,199,493	11.610

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	4,135,557	35,958,651	11.223
90%	4,652,502	36,547,004	11.407
100%	5,169,447	37,135,358	11.590
110%	5,686,391	37,723,711	11.774
120%	6,203,336	38,312,065	11.957

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-149,970	37,285,329	11.637
-10%	-99,980	37,235,338	11.621
-5%	-49,990	37,185,348	11.606
0%	0	37,135,358	11.590
5%	49,990	37,085,368	11.575
10%	99,980	37,035,377	11.559
15%	149,970	36,985,387	11.543

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	70,177,616	21.903
0.5%	64,909,791	20.259
1.5%	55,844,949	17.430
2.5%	48,401,080	15.106
3.5%	42,249,979	13.187
4.5%	37,135,358	11.590
5.5%	32,856,137	10.255
6.5%	29,253,815	9.130
7.5%	26,202,864	8.178
8.5%	23,603,405	7.367

Table 47 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 5
File: FGD6 Type: New plant (NP) 05/13/92
Desc: FORT GORDON
Tech: Gas / Oil Fired Boiler

****
Sensitivity Analysis, cont
****

10.5%	19,455,307	6.072
11.5%	17,790,803	5.552
12.0%	17,041,039	5.318

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	20,245,614	11.841
11 yr	21,605,160	11.723
12 yr	22,948,136	11.647
13 yr	24,241,311	11.586
14 yr	25,497,253	11.543
15 yr	26,764,610	11.534
16 yr	27,950,655	11.515
17 yr	29,097,989	11.503
18 yr	30,224,349	11.503
19 yr	31,302,163	11.503
20 yr	32,411,164	11.531
21 yr	33,429,317	11.542
22 yr	34,401,581	11.550
23 yr	35,341,472	11.561
24 yr	36,257,296	11.576
25 yr	37,135,358	11.590

Table 46

Cost Sensitivity Analysis for Coal-Fired Stoker Plant

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 1
File: FGDC Type: New plant (NP) 05/13/92
Desc: FORT GORDON
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Base and Plant Information
****

State: GA - Georgia Base DOE Region: 3
PMCR: 100,000 lb/hr steam Number of boilers: 4

Coal code: W205320 Distance from base: 278 miles
State: KY - Kentucky DOE Region: 3
Coal type: bituminous (properties on a dry basis)
hhv: 12870 Btu/lb fixed carbon: 52.20% volatiles: 38.10%
ash: 9.70% sulfur: 0.50%

Coal handling equipment capacity: 50 tons/hr
Coal silo storage capacity: 374 tons
Approx. building width: 58 feet
Approx. building length: 141 feet
Height of the plant: 59 ft
Building area: 8210 sq ft
Plant area: 1.31 acres

****
Facility Parameters
****

Capital Equipment Escalation Factor: 1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor: 1.106 (947.10/1991)
Operation & Maintenance Labor Escalation Factor: 1.061 (4386.55/1991)
Construction Labor Escalation Factor: 1.030 (272.70/1991)

Annual diesel/distillate fuel usage: 16,400 gallons
Annual electricity usage: 2,704,433 kW-hr
Annual lime usage: 261 tons

1991 cost for coal: 1.715 $/MMBtu
1991 cost for distillate: 0.631 $/gallon
1991 cost for electricity: 0.053 $/kW-hr

Annual Facility Output: 257,664 thousand lb steam
Annual Coal Usage: 13,398 tons (dry) / 14,202 tons (wet)
Heating plant efficiency: 84%
Year of Study: 1991
Years of Operation: 1995 - 2019

****
Facility Installed Capital Costs
****

Equipment		Cost	Equipment		Cost
Boiler:	$	9,318,324	Coal Handling:	$	4,995,812
Ash Handling:	$	2,047,997	Mechncl Collector:	$	134,619

Table 48 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 2
File: FGDC Type: New plant (NP) 05/13/92
Desc: FORT GORDON
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Facility Installed Capital Costs, cont
****

Water Treatment:	$	696,631	Pumps:	$	172,781
Air Compressor:	$	72,152	Waste Water Trtmnt:	$	97,065
Piping/Stack:	$	3,300,834	Electrical System:	$	1,630,032
Building Costs:	$	3,710,787	Direct costs:	$	10,521,182

****
Plant installed cost: $ 44,689,453

****
Facility Annual O & M and Energy Costs
****

Operating staff: 22
Annual Labor Costs: $ 963,353

First Year Non-Labor O & M Costs	: $	1,338,611
Annual Year Non-Labor O & M Costs	: $	1,663,506
1995 Coal Costs (incl transport)	: $	730,510
1995 Auxiliary Energy Costs	: $	156,265

****
Periodic Major Maintenance Cost Summary
****

Time Interval	Cost	Time Interval	Cost
3 years	$ 95,774	5 years	$ 92,079
7 years	$ 79,583	8 years	$ 222,604
10 years	$ 542,186	12 years	$ 44,074
15 years	$ 9,352	18 years	$ 11,754
20 years	$ 427,964		

****
Facility Life Cycle Cost Summary
****

+ PV 'Adjusted' Investment Costs	= $ 39,161,216
+ PV Energy + Transportation Costs	= $ 12,773,403
+ PV Annually Recurring O&M Costs	= $ 21,343,004
+ PV Non-Annually Recurring Repair & Replacement	= $ 1,728,076
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 75,005,701

Levelized Cost of Service (1995 start) = 19.580 $/MMBtu

Table 48 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 3
File: FGDC Type: New plant (NP) 05/13/92
Desc: FORT GORDON
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****

Sensitivity Analysis

****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	5,269,249	69,736,451	21.766
60%	6,323,099	70,790,301	22.095
70%	7,376,949	71,844,151	22.424
80%	8,430,799	72,898,001	22.752
90%	9,484,649	73,951,851	23.081
100%	10,538,499	75,005,701	23.410
110%	11,592,349	76,059,551	23.739
120%	12,646,199	77,113,401	24.068
130%	13,700,049	78,167,251	24.397
140%	14,753,899	79,221,101	24.726
150%	15,807,749	80,274,951	25.055

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	7,637,237	72,104,439	22.505
-2%	8,469,298	72,936,500	22.765
-1%	9,428,862	73,896,064	23.064
0%	10,538,499	75,005,701	23.410
1%	11,824,979	76,292,181	23.812
2%	13,320,050	77,787,252	24.279
3%	15,061,375	79,528,577	24.822
4%	17,093,624	81,560,826	25.456
5%	19,469,776	83,936,978	26.198
6%	22,252,654	86,719,856	27.067

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	1,787,923	74,558,721	23.271
90%	2,011,413	74,782,211	23.341
100%	2,234,903	75,005,701	23.410
110%	2,458,394	75,229,192	23.480
120%	2,681,884	75,452,682	23.550

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	10,014,185	72,502,155	22.629
90%	11,265,959	73,753,928	23.020
100%	12,517,732	75,005,701	23.410
110%	13,769,505	76,257,475	23.801
120%	15,021,278	77,509,248	24.192

=== O&M non-labor cost variation ===

Table 48 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 4
File: FGDC Type: New plant (NP) 05/13/92
Desc: FORT GORDON
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

Sensitivity Analysis, cont

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	7,060,217	73,240,647	22.859
90%	7,942,744	74,123,174	23.135
100%	8,825,272	75,005,701	23.410
110%	9,707,799	75,888,229	23.686
120%	10,590,326	76,770,756	23.961

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	1,382,461	74,660,086	23.302
90%	1,555,269	74,832,894	23.356
100%	1,728,076	75,005,701	23.410
110%	1,900,884	75,178,509	23.464
120%	2,073,692	75,351,317	23.518

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	31,328,973	65,531,186	20.453
90%	35,245,095	70,268,443	21.932
100%	39,161,216	75,005,701	23.410
110%	43,077,338	79,742,959	24.889
120%	46,993,460	84,480,217	26.368

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-1,076,295	76,081,997	23.746
-10%	-717,530	75,723,232	23.634
-5%	-358,765	75,364,467	23.522
0%	0	75,005,701	23.410
5%	358,765	74,646,936	23.298
10%	717,530	74,288,171	23.186
15%	1,076,295	73,929,406	23.074

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	114,883,502	35.857
0.5%	108,752,158	33.943
1.5%	98,046,923	30.602

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 5
File: FGDC   Type: New plant (NP)   05/13/92
Desc: FORT GORDON
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Sensitivity Analysis, cont
****

3.5%	81,476,003	25.430
4.5%	75,005,701	23.410
5.5%	69,447,846	21.676
6.5%	64,636,946	20.174
7.5%	60,441,375	18.865
8.5%	56,755,905	17.714
9.5%	53,495,984	16.697
10.5%	50,593,320	15.791
11.5%	47,992,470	14.979
12.0%	46,790,747	14.604

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	57,634,746	33.710
11 yr	59,062,868	32.050
12 yr	60,507,693	30.711
13 yr	61,827,201	29.552
14 yr	63,132,462	28.582
15 yr	64,438,106	27.769
16 yr	65,703,522	27.068
17 yr	66,826,947	26.418
18 yr	67,949,340	25.862
19 yr	68,987,116	25.353
20 yr	70,370,575	25.037
21 yr	71,390,338	24.648
22 yr	72,311,964	24.279
23 yr	73,197,921	23.945
24 yr	74,160,051	23.678
25 yr	75,005,701	23.410

Table 49

Picatinny Arsenal Heating Plant Information

Plant	Boiler	Fuel	Reserve	Year Installed	Capacity (lb/hr)	In use	Rating	Energy Use Heat/Cool/ Process/Losses/ Internal/Pwr Gen
506	1	#6 Oil	#2 Oil	1971	50000	Y	5	H/C
506	2	#6 Oil	#2 Oil	1958	160000	Y	5	H/C
506	3	#6 Oil	#2 Oil	1958	160000	Y	5	H/C
99	1	#6 Oil	#2 Oil	1987	10000	Y	10	H
3013	1	#6 Oil	#2 Oil	1970	50000	Y	2	H
				(Total)	430000			

Table 50

Picatinny Arsenal Energy Use Data

Fuel	Units	Btu/Unit	$/Unit	1989 Use	1990 Use	$/MBtu	MBtu '90	MBtu '89
Dist. oil	gal	138700	0.51	297570	0	3.68	0	41273
Res. oil	gal	149690	0.45	6299916	0	3.01	0	943034
Nat. gas	Total NAG use:			0	0		0	0
Interr.	kscf	0	0.00					
Unintr.	kscf	0	0.00					
Building:		506						
Capacity (lb/hr):		410000						
SQ file:		PIC1						
Annual Costs		890000						
Labor		500000						
Utilities		100000						
Service		100000						
Supplies								
Average steam production, 1989 (lb/hr):								
October		71010						
November		80830						
December		108270						
Januar.		120960						
February		124570						
March		116600						
April		95700						
May		62780						
June		27610						
July*		25000						
August*		30000						
September*		50000						
Fuel energy, based on steam production, 1989 (MBtu)								
October		63652.3						
November		70117.6						
December		97051.7						
January		108426.8						
February		100856.7						
March		104518.6						

* = *estimated*

Table 50 (Cont'd)

Fuel	Units	Btu/Unit	$/Unit	1989 Use	1990 Use	$/MBtu	MBtu '90	MBtu '89
Fuel energy, based on steam production, 1989 (MBtu) (cont'd):								
April		83016.9						
May		56275.1						
June		23950.8						
July		22409.6						
August		26891.6						
September		43373.5						
Total (MBtu/yr)		800541.1					800541.1	
Percent of total		100.0						
Reserve fuel		#2						
Fuel use (MBtu/year):							Total	
Natural Gas		0.0					0	
Dist. Oil		36024.3					36024	
Res. Oil		764516.8					764517	
Total $/yr:		4020762				ERR		
$/MBtu:								
Labor		1.11						
Utilities		0.62						
Service		0.12						
Supplies		0.12						
Fuel		3.03					Average	
Total $/MBtu		5.02					5.02	
Reported $/MBtu:		5.28						

Table 51a

Boiler Evaluation Parts List—Picatinny Arsenal Bldg. 506

Equipment	Year Installed	Units	Specification	1	Specification	2	Condition
A. Boiler (WT)	1971	1	50	MBtu/hr			Good
1. Boiler Pressure Parts and Setting			450	psig	600	temp	
2. Relief Valve(s)	1971	3	1.5	in.	600	psig	Good
3. Feedwater Regulator(s)	1971	1	2	in.	600	psig	Good
4. Boiler Burner(s)	1971	1	75	MBtu			Fair
5. Boiler Fan(s) (FD)	1971	1	75	Hp			Good
7. Boiler Drum Level Control	1971	1					Fair
A. Boiler (WT)	1958	2	180	MBtu/hr			Good
1. Boiler Pressure Parts and Setting	(1982-25 yr life)		430	psig	600	temp	
2. Relief Valve(s)	1988	3	3	in.	600	psig	Good
2. Relief Valve(s)	1988	1	2.5	in.	600	psig	Good
2. Relief Valve(s)	1989	3	3	in.	600	psig	Good
2. Relief Valve(s)	1989	1	2.5	in.	600	psig	Good
3. Feedwater Regulator(s)	1954	2	4	in.	600	psig	Fair
4. Boiler Burner(s)	1980	8	50	MBtu			Good
5. Boiler Fan(s) (FD)	1958	1	150	Hp			Fair
5. Boiler Fan(s) (ID)	1987	1	200	Hp			Good
5. Boiler Fan(s) (FD)	1958	1	100	Hp			Fair
5. Boiler Fan(s) (ID)	1987	1	250	Hp			Good
6. Boiler Air Heater	1975	2	200	MBtu			Fair
7. Boiler Drum Level Control	1986	2					Good

Table 51a (Cont'd)

Equipment	Year Installed	Units	Specification 1		Specification 2		Condition
B. Feedwater System							
8. Deaerating Heater	1983	1	330000	lb/hr			Good
8. Deaerating Heater	1988	1	350000	lb/hr			Good
12. Condensate Pumps	1980	4	5	Hp			Good
12. Condensate Pumps	1991	1	5	Hp			Good
13. Condensate Receiver	1980	1	8600	Gal			Good
13. Condensate Receiver	1980	1	200	Gal			Fair
13. Condensate Receiver	1980	1	250	Gal			Fair
14. Boiler Feed Pumps	1990	1	150	Hp			Good
14. Boiler Feed Pumps	1986	1	131	Hp			Good
14. Boiler Feed Pumps	1981	2	250	Hp			Fair
14. Boiler Feed Pumps	1986	1	150	Hp			Fair
14. Boiler Feed Pumps	1965	1	250	Hp			Fair
14. Boiler Feed Pumps	1986	1	200	Hp			Good
15. Make-up Pumps	1986	3	50	Hp			Fair
15. Make-up Pumps	1986	1	40	Hp			Fair
15. Make-up Pumps	1990	1	50	Hp			Good
19. Feedwater Piping System (valve)	1991	10	4	diam (in.)	150	psig	Good
20. Cooling Water Pumps	1991	1	20	Hp			Fair
20. Cooling Water Pumps	1991	2	30	Hp			Fair
20. Cooling Water Pumps	1991	1	25	Hp			Fair
20. Cooling Water Pumps	Unknown	2	150	Hp	(not in use)		Fair
20. Cooling Water Pumps	Unknown	2	250	Hp	(not in use)		Fair
20. Cooling Water Pumps	Unknown	1	25	Hp	(not in use)		Fair
C. Fuel Handling System							
2. Fuel Oil Tank - Above ground	1970	2	400000	gal			Good
2. Fuel Oil Tank - Above ground	1980	2	800000	gal			Good
4. Fuel Oil Pump	1985	1	____	gpm	15	Hp	Good
4. Fuel Oil Pump	1970	2	____	gpm	15	Hp	Fair
5. Fuel Oil Heater	1970	3	30	gpm			Fair
6. Fuel Oil Piping System (BLW)	1970	50	4	diam (in.)			Fair
6. Fuel Oil Piping System (BLW)	1970	50	6	diam (in.)			Fair
6. Fuel Oil Piping System (ABV)	1970	500	6	diam (in.)			Fair
7. Natural Gas Piping (ABV)	1980	____	8	diam (in.)			Good
7. Natural Gas Piping (BLW)	1990	____	8	diam (in.)			Good
D. Heat Recovery System							
1. Blowdown Flash Tank	1986	1	3.5	diam (ft)	5	height (ft)	Good
1. Blowdown Flash Tank	1986	1	6	diam (ft)	8	height (ft)	Good
2. Blowdown Heat Exchanger	1977	1	18	gpm			Fair
2. Blowdown Heat Exchanger	1988	1	18	gpm			Good

Table 51a (Cont'd)

Equipment	Year Installed	Units	Specification 1		Specification 2		Condition
E. Air Pollution Control Systems and Emissions Monitoring							
4. Breeching	1974	1	16	sq ft			Good
4. Breeching	1955	2	36	sq ft			Good
5. Stack	1974	1	4	diam (ft)	65	height (ft)	Good
5. Stack	1980	2	6	diam (ft)	60	height (ft)	Good
6. Opacity Monitor	1970	3					Fair
F. Combustion Controls							
1. Plant Master	1985	1					Good
2. Boiler Master	1970	1					Fair
2. Boiler Master	1985	2					Good
3. Flame Safeguard System	1970	1					Fair
3. Flame Safeguard System	1980	1					Good
4. Furnace Draft Control (DAMPACT)	1954	2					Fair
5. Additional Boiler	1991	3		FLOWMETER, [illegible]MPREC			Fair
Instrumentation/Indicators	1985	2		PSIG CONTROL/SENSOR			Fair
G. Chemical Feed System							
1. Chemical Storage Tanks and Pumps	1991	5	200	gal	0.333	Hp	Good
H. Make-up Water System							
5. Pressure Filter	1973	3	300	gpm			Fair
9. Sodium Zeolite Softener	1973	3	200	gpm			Good
I. Condensate Polishing							
J. Compressed Air System							
1. Air Compressor (RECIP)	1988	2	750	SCFM			Fair
1. Air Compressor (ROT SCRW)	1980	1	250	SCFM			Fair
1. Air Compressor (RECIP)	1983	1	50	SCFM			Fair
2. Air Dryer (REFR)	1986	1	50	SCFM			Good
3. Air Receiver	1991	1	600	gal			Good
3. Air Receiver	1981	1	600	gal			Fair
3. Air Receiver	1971	1	400	gal			Fair
K. Electrical System							
1. Transformer	1990	1	1500	KVA			Good
1. Transformer	1970	1	750	KVA			Fair
1. Transformer	1970	3	150	KVA			Fair
2. Switchgear -- Main Circuit Breaker	1954	1	2000	amps			Poor
3. Motor Control Center/Starter	1954	3	500	amps			Poor
3. Motor Control Center/Starter	1954	3	1000	amps			Poor

Table 51a (Cont'd)

Equipment	Year Installed	Units	Specification 1	Specification 2	Condition
L. Physical Plant					
1. Building Siding, Roofing, Windows, and Doors	1954	—	—		Fair
2. Building Concrete and Building Steel	1954	—	—		Fair
4. Building Lighting	1954	—	—		Fair

Table 51b

Status Quo Life Cycle Cost Analysis for Picatinny Arsenal Building 506

```
      LIFE CYCLE COST ANALYSIS                       STUDY: TDPIC1
LCCID  1.065                  DATE/TIME:  05-19-92  13:13:31
PROJECT NO., FY, & TITLE:      FY 1992    BUILDING 506
INSTALLATION & LOCATION: PICATINNY ARSENAL    NEW JERSEY
DESIGN FEATURE:
ALT. ID. A;   TITLE: STATUS QUO
NAME OF DESIGNER:
```

BASIC INPUT DATA SUMMARY

CRITERIA REFERENCE:Tri-Service MOA for Econ Anal/LCC (Energy)

DISCOUNT RATE: 4.6%

KEY PROJECT-CALENDAR INFORMATION

DATE OF STUDY (DOS)	MAY 92
MIDPOINT OF CONSTRUCTION (MPC)	JUN 92
BENEFICIAL OCCUPANCY DATE (BOD)	JAN 93
ANALYSIS END DATE (AED)	JAN 18

COST / BENEFIT DESCRIPTION	COST IN DOS $ ($ X 10**0)	EQUIVALENT UNIFORM DIFFERENTIAL ESCALATION RATE (% PER YEAR)	TIME(S) COST INCURRED
INVESTMENT COSTS	.0	.00	JUN 92
DISTILLATE OIL	132568.3	1.50	JUL93-JUL17
RESIDUAL OIL	2301196.0	2.01	JUL93-JUL17
MAINT LABOR	890000.0	.00	JUL93-JUL17
MAINT SERV	100000.0	.00	JUL93-JUL17
MAINT SUPPLY	100000.0	.00	JUL93-JUL17
MAINT UTIL	500000.0	.00	JUL93-JUL17
BREECH	1900.0	.00	JAN 14
BREECH	3800.0	.00	JAN 95
OPACMONITOR	75000.0	.00	JAN 00
STACK	18000.0	.00	JAN 14
AIRHEAT	200000.0	.00	JAN 95
DRUMCTL	5000.0	.00	JAN 96
DRUMCTL	10000.0	.00	JAN 06
FW_REG	900.0	.00	JAN 11
FW_REG	2200.0	.00	JAN 94
F_FAN	25000.0	.00	JAN 11
F_FAN	30000.0	.00	JAN 98
F_FAN	40000.0	.00	JAN 98
RELVALVE	5400.0	.00	JAN 96
RELVALVE	2250.0	.00	JAN 08
RELVALVE	2250.0	.00	JAN 09
RELVALVE	7950.0	.00	JAN 08
RELVALVE	7950.0	.00	JAN 09
WTBOILER	975000.0	.00	JAN 11
WTBOILER	4379754.0	.00	JAN 07
WTBURNER	100000.0	.00	JAN 11
PUMPSIMPLEX	15000.0	.00	JAN 11
TANKSTEEL	2500.0	.00	JAN 11
BOILMASTER	5000.0	.00	JAN 00

Table 51b (Cont'd)

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    LIFE CYCLE COST ANALYSIS                        STUDY: TDPIC1
LCCID  1.065                   DATE/TIME:  05-19-92  13:13:31
PROJECT NO., FY, & TITLE:      FY 1992    BUILDING 506
INSTALLATION & LOCATION: PICATINNY ARSENAL    NEW JERSEY
DESIGN FEATURE:
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER:
```

BASIC INPUT DATA SUMMARY

BOILMASTER	10000.0	.00	JAN 15
DAMPACT	2000.0	.00	JAN 99
FLAMESAFE	10000.0	.00	JAN 00
FLAMESAFE	20000.0	.00	JAN 10
PLANTMASTER	5000.0	.00	JAN 15
PSIGCTRL	5000.0	.00	JAN 15
PSIGSENSOR	2000.0	.00	JAN 15
AIRCOMPRECIP	20000.0	.00	JAN 03
AIRCOMPRECIP	42000.0	.00	JAN 00
AIRCOMPRECIP	192000.0	.00	JAN 08
AIRDRYERREFR	12000.0	.00	JAN 01
AIRRECV	1900.0	.00	JAN 01
AIRRECV	2500.0	.00	JAN 11
MOTORCTRL	8700.0	.00	JAN 94
MOTORCTRL	16200.0	.00	JAN 94
SWITCH	25000.0	.00	JAN 94
TRANSFORMER	57000.0	.00	JAN 10
TRANSFORMER	28500.0	.00	JAN 10
CONDPUMP	18000.0	.00	JAN 00
CONDPUMP	4500.0	.00	JAN 11
CONDREC	8000.0	.00	JAN 10
CONDREC	9000.0	.00	JAN 10
CONDREC	56000.0	.00	JAN 10
COOLPUMP	7000.0	.00	JAN 11
COOLPUMP	7600.0	.00	JAN 11
COOLPUMP	7600.0	.00	JAN 11
COOLPUMP	16400.0	.00	JAN 11
COOLPUMP	22800.0	.00	JAN 11
COOLPUMP	22800.0	.00	JAN 11
FEEDPUMP	30820.0	.00	JAN 16
FEEDPUMP	35000.0	.00	JAN 16
FEEDPUMP	74000.0	.00	JAN 11
FEEDPUMP	37000.0	.00	JAN 95
FEEDPUMP	37000.0	.00	JAN 16
FWPIPINGVAL	11000.0	.00	JAN 11
MUPUMP	9933.0	.00	JAN 06
MUPUMP	34200.0	.00	JAN 06
MUPUMP	11400.0	.00	JAN 10
HEATER	15000.0	.00	JAN 00
NAGPIPEBELOW	54.0	.00	JAN 15
OILPIPEBELOW	2450.0	.00	JAN 95
OILPIPEBELOW	4300.0	.00	JAN 95
PUMP	5000.0	.00	JAN 10
PUMP	10000.0	.00	JAN 95
TANKABOVE	360000.0	.00	JAN 10
FLASHTANK	1550.0	.00	JAN 11
FLASHTANK	2000.0	.00	JAN 11
HEATEXCH	1520.0	.00	JAN 07
HEATEXCH	1520.0	.00	JAN 18

Table 51b (Cont'd)

LIFE CYCLE COST ANALYSIS STUDY: TDPIC1
LCCID 1.065 DATE/TIME: 05-19-92 13:13:31
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 506
INSTALLATION & LOCATION: PICATINNY ARSENAL NEW JERSEY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

BASIC INPUT DATA SUMMARY

FILTERPRESS	69000.0	.00	JAN 93
SZSOFT	474999.0	.00	JAN 93

OTHER KEY INPUT DATA

LOCATION - NEW JERSEY CENSUS REGION: 1
RATES FOR INDUSTRIAL SECTOR. TABLES FROM OCT 91

ENERGY USAGE: 10**6 BTUS ELECTRIC DEMAND: 10**0 DOLLARS

ENERGY TYPE	$/MBTU	AMOUNT	ELECT. DEMAND	PROJECTED DATES
DIST	3.68	36024.0		JAN93-JAN18
RESID	3.01	764517.0		JAN93-JAN18

Table 51b (Cont'd)

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    LIFE CYCLE COST ANALYSIS                       STUDY: TDPIC1
LCCID  1.065                  DATE/TIME:  05-19-92  13:13:31
PROJECT NO., FY, & TITLE:      FY 1992    BUILDING 506
INSTALLATION & LOCATION: PICATINNY ARSENAL     NEW JERSEY
DESIGN FEATURE:
ALT. ID. A;    TITLE: STATUS QUO
NAME OF DESIGNER:

                LIFE CYCLE COST TOTALS*

INITIAL INVESTMENT COSTS                                    0.

ENERGY COSTS:

DISTILLATE OIL                          2264606.
RESIDUAL OIL                           41904900.

TOTAL ENERGY COSTS                                   44169500.

RECURRING M&R/CUSTODIAL COSTS                        23161800.

MAJOR REPAIR/REPLACEMENT COSTS                        4270156.

OTHER O&M COSTS & MONETARY BENEFITS                         0.

DISPOSAL COSTS/RETENTION VALUE                              0.

LCC OF ALL COSTS/BENEFITS (NET PW)                   71601460.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91
```

LIFE CYCLE COST ANALYSIS STUDY: TDPIC1
LCCID 1.065 DATE/TIME: 05-19-92 13:13:31
PROJECT NO., FY, & TITLE: FY 1992 BUILDING 506
INSTALLATION & LOCATION: PICATINNY ARSENAL NEW JERSEY
DESIGN FEATURE:
ALT. ID. A; TITLE: STATUS QUO
NAME OF DESIGNER:

YEAR-BY-YEAR BREAKDOWN OF LIFE CYCLE COSTS*

DOLLARS IN 10**0

BENEFICIAL OCCUPANCY DATE: JAN93
ANNUAL PAYMENTS OCCUR: JUL93 THROUGH JUL17

PAY	DIST	RESID	M & R	R / R	OTHER
1	126772.	2257201.	1508725.	527931.	0.
2	121289.	2200865.	1442376.	48338.	0.
3	115696.	2136345.	1378945.	228443.	0.
4	110589.	2047090.	1318303.	8819.	0.
5	105823.	1952730.	1260328.	0.	0.
6	101769.	1874440.	1204902.	54252.	0.
7	99260.	1830506.	1151914.	1482.	0.
8	97411.	1800943.	1101256.	116880.	0.
9	95858.	1776390.	1052826.	9413.	0.
10	94709.	1759094.	1006526.	0.	0.
11	93560.	1741913.	962262.	12379.	0.
12	92296.	1720989.	919945.	0.	0.
13	90979.	1699294.	879488.	0.	0.
14	89244.	1668088.	840811.	29277.	0.
15	87202.	1629172.	803834.	2265352.	0.
16	84796.	1581665.	768484.	99950.	0.
17	82182.	1529001.	734688.	4820.	0.
18	79323.	1475372.	702379.	250700.	0.
19	76826.	1429119.	671490.	560704.	0.
20	74827.	1391932.	641960.	0.	0.
21	72958.	1357166.	613729.	0.	0.
22	70963.	1320071.	586739.	7510.	0.
23	68956.	1282734.	560936.	7957.	0.
24	66723.	1241193.	536267.	35467.	0.
25	64594.	1201591.	512684.	0.	0.
***	2264606.	********	********	4270156.	0.

*NET PW EQUIVALENTS ON MAY92; IN 10**0 DOLLARS; IN CONSTANT MAY92 DOLLARS
*ENERGY ESCALATION RATES FROM NIST HANDBOOK 135 SUPPLEMENT DATED OCT 91

Table 52

CHPECON Run Results for Picatinny Arsenal Bldg. 506

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
GAS	124/124/124	9.340	11.167	11539	123089	145468	100
#2 OIL	124/124/124	10.513	12.570	11539	141366	163744	113
#6 OIL	124/124/124	8.052	9.627	11539	103024	125403	86
STOKER	84/144/144/144	11.206	13.397	81979	50484	174524	120
CWS	72/144/184/184	10.841	12.961	72567	71777	176779	122
COM	88/151/151/151	10.581	12.650	51153	93558	172536	119
FBC	67/134/171/171	12.342	14.756	80809	69238	192226	132
				K$INV	K$COAL	K$ HVY OIL	SAVINGS
Retrofit							
STOKER	45/144/144			5044	48230	-118672	-65397
CWS	37/120/120			4378	67203	-152423	-80841
M-COAL	37/120/120			6660	47303	-116390	-62426

FILE PREFIX: PAR1
PMCR: 370 L
AVE MON. LOAD: 123 M
CHP #1 2@ 160 L FUEL = FS6 AGE = 1952/1954
1@ 50 L FUEL = FS6 AGE = 1971
L=(K# STEAM/HR)
M=(MBTU/HR)

Table 53

CHPECON Run Results for Picatinny Arsenal Bldg. 3013

Technology	Boiler	$/MBTU	$/K#STM	K$INV.	K$FUEL	K$LCC	LCC/R
New Plant							
GAS	17/17/17	13.255	15.848	4406	17727	29347	100
#2 OIL	17/17/17	14.423	17.244	4406	20313	31932	109
#6 OIL	17/17/17	11.964	14.304	4406	14868	26488	90
STOKER	12/20/20/20	30.417	36.367	37350	8439	67342	229
CWS	10/20/25/25	23.729	28.371	25050	10969	54900	187
COM	12/21/21/21	23.550	28.156	22199	14234	54484	186
FBC	9/18/23/23	28.423	33.982	34038	7617	62927	214
				K$INV	K$COAL	K$ HVY OIL	SAVINGS
Retrofit							
STOKER							
CWS							
M-COAL							

FILE PREFIX: PAR2
PMCR: 50 L
AVE MON. LOAD: 17 M
CHP #2 1@ 50 L FUEL = FS6 AGE = 1970
L=(K# STEAM/HR)
M=(MBTU/HR)

Table 54

Cost Sensitivity Analysis for a Gas/#2 Oil-Fired Boiler Plant

---

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 1
File: FPIC Type: New plant (NP) 05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

****

Base and Plant Information

****

State: NJ - New Jersey Base DOE Region: 1
PMCR: 250,000 lb/hr steam Number of boilers: 3

Height of the plant: 40 ft
Building area: 9000 sq ft
Plant area: 1.97 acres

****

Facility Parameters

****

Capital Equipment Escalation Factor: 1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor: 1.106 (947.10/1991)
Operation & Maintenance Labor Escalation Factor: 1.061 (4386.55/1991)
Construction Labor Escalation Factor: 1.030 (272.70/1991)

Annual electricity usage: 1,635,533 kW-hr

1991 cost for distillate: 0.662 $/gallon
1991 cost for residual: 0.445 $/gallon
1991 cost for natural gas: 4.150 $/million Btu
1991 cost for electricity: 0.044 $/kW-hr

Annual Facility Output: 852,120 thousand lb steam
Annual Natural Gas Usage: 1,046 10^6 SCF
Heating plant efficiency: 83.2% natural gas
Year of Study: 1991
Years of Operation: 1995 - 2019

****

Facility Capital Costs

****

Equipment		Cost	Equipment		Cost
Boiler:	$	1,673,069	Stack:	$	32,911
Building/service:	$	1,377,326	Water trtmnt:	$	909,326
Feedwtr pmps:	$	31,154	Cond xfr pmps:	$	32,200
Cond strg tnk:	$	8,362	Oil (long) storage:	$	340,749
Oil day strg pmp:	$	5,015	Oil heaters:	$	8,880
Oil day strg tanks:	$	22,120	Oil unload pumps:	$	13,791
Oil xfr pmps:	$	6,425	Fire protection:	$	52,241
Cont bldn tnk:	$	1,175	Intr bldn tnk:	$	1,175
Compressor:	$	24,453	Car puller:	$	20,896
Rail:	$	22,202	Site preparation:	$	5,145
Site improvements:	$	235,085	Mobile equipment:	$	40,748
Elec substation:	$	71,237	Electrical:	$	197,854
Piping:	$	1,121,176	Instrumentation:	$	414,552
Direct costs:	$	2,458,250			

Table 54 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 2
File: FPIC Type: New plant (NP) 05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

****
Facility Capital Costs, cont
****

Plant installed cost: $ 10,622,206

****
Facility Annual O & M and Energy Costs
****

Operating staff: 11
Annual Labor Costs: $ 463,732
Annual Year Non-Labor O & M Costs : $ 714,017
1995 Natural gas costs : $ 5,382,747
1995 Auxiliary Energy Costs : $ 72,323

****
Periodic Major Maintenance Cost Summary
****

Time Interval	Cost	Time Interval	Cost
3 years	$ 30,000	5 years	$ 6,545
10 years	$ 380,276	15 years	$ 112,846
18 years	$ 12,880	20 years	$ 14,981

****
Facility Life Cycle Cost Summary
****

Analysis using natural gas as primary fuel	
+ PV 'Adjusted' Investment Costs	= $ 9,308,203
+ PV Energy + Transportation Costs	= $ 100,259,214
+ PV Annually Recurring O&M Costs	= $ 9,261,152
+ PV Non-Annually Recurring Repair & Replacement	= $ 551,423
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 119,379,993

Levelized Cost of Service (1995 start) = 9.4237 $/MMBtu
Levelized Cost of Service (1995 start) = 11.266 $/1000 lb steam

****
Sensitivity Analysis
****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	49,617,335	69,762,657	6.584
60%	59,540,803	79,686,125	7.520

Table 54 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 3
File: FPIC Type: New plant (NP) 05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

****
Sensitivity Analysis, cont
****

80%	79,387,737	99,533,059	9.393
90%	89,311,204	109,456,526	10.330
100%	99,234,671	119,379,993	11.266
110%	109,158,138	129,303,460	12.203
120%	119,081,606	139,226,928	13.140
130%	129,005,073	149,150,395	14.076
140%	138,928,540	159,073,862	15.013
150%	148,852,007	168,997,329	15.949

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	70,124,292	90,269,614	8.519
-2%	78,428,555	98,573,877	9.303
-1%	88,053,064	108,198,386	10.211
0%	99,234,671	119,379,993	11.266
1%	112,254,463	132,399,785	12.495
2%	127,446,043	147,591,365	13.929
3%	145,205,331	165,350,653	15.605
4%	166,002,156	186,147,478	17.568
5%	190,393,953	210,539,275	19.870
6%	219,041,942	239,187,264	22.574

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	819,634	119,175,085	11.247
90%	922,088	119,277,539	11.257
100%	1,024,542	119,379,993	11.266
110%	1,126,997	119,482,448	11.276
120%	1,229,451	119,584,902	11.286

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	4,820,558	118,174,853	11.153
90%	5,423,128	118,777,423	11.210
100%	6,025,698	119,379,993	11.266
110%	6,628,268	119,982,563	11.323
120%	7,230,838	120,585,133	11.380

=== O&M non-labor cost variation ===

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	2,588,362	118,732,903	11.205
90%	2,911,908	119,056,448	11.236
100%	3,235,453	119,379,993	11.266
110%	3,558,999	119,703,539	11.297

Table 54 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 4
File: FPIC   Type: New plant (NP)   05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	441,138	119,269,709	11.256
90%	496,281	119,324,851	11.261
100%	551,423	119,379,993	11.266
110%	606,565	119,435,136	11.272
120%	661,708	119,490,278	11.277

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	7,446,562	117,304,377	11.071
90%	8,377,382	118,342,185	11.169
100%	9,308,203	119,379,993	11.266
110%	10,239,023	120,417,801	11.364
120%	11,169,843	121,455,609	11.462

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-252,951	119,632,945	11.290
-10%	-168,634	119,548,628	11.282
-5%	-84,317	119,464,310	11.274
0%	0	119,379,993	11.266
5%	84,317	119,295,676	11.259
10%	168,634	119,211,359	11.251
15%	252,951	119,127,042	11.243

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	234,418,532	22.124
0.5%	215,972,753	20.383
1.5%	184,305,621	17.394
2.5%	158,389,335	14.948
3.5%	137,052,184	12.934
4.5%	119,379,993	11.266
5.5%	104,656,217	9.877
6.5%	92,316,614	8.712
7.5%	81,914,829	7.731
8.5%	73,096,135	6.898

Table 54 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 5
File: FPIC Type: New plant (NP) 05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

10.5%	59,131,292	5.580
11.5%	53,575,019	5.056
12.0%	51,083,109	4.821

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	59,198,507	10.470
11 yr	63,835,860	10.474
12 yr	68,450,718	10.505
13 yr	73,032,368	10.555
14 yr	77,540,729	10.615
15 yr	82,034,653	10.689
16 yr	86,333,369	10.754
17 yr	90,490,070	10.817
18 yr	94,534,274	10.879
19 yr	98,435,401	10.938
20 yr	102,359,849	11.012
21 yr	106,014,940	11.068
22 yr	109,530,323	11.120
23 yr	112,927,419	11.170
24 yr	116,212,708	11.219
25 yr	119,379,993	11.266

Table 55

Cost Sensitivity Analysis for a #6 Oil-Fired Boiler Plant

```
Central Heating Plant Economics Evaluation -- Sensitivity Analysis      Page 1
File: FPIC6         Type: New plant (NP)                              05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

*******************************************************************************
   Base and Plant Information
*******************************************************************************

State: NJ - New Jersey            Base DOE Region: 1
PMCR: 250,000 lb/hr steam      Number of boilers: 3

Height of the plant: 40 ft
Building area: 9000 sq ft
Plant area: 1.97 acres

*******************************************************************************
   Facility Parameters
*******************************************************************************

Capital Equipment Escalation Factor:  1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor:  1.106 ( 947.10/1991)
Operation & Maintenance Labor Escalation Factor:  1.061 (4386.55/1991)
Construction Labor Escalation Factor:  1.030 ( 272.70/1991)

Annual electricity usage: 1,635,533 kW-hr

1991 cost for distillate:  0.662 $/gallon
1991 cost for residual:  0.445 $/gallon
1991 cost for natural gas:  4.150 $/million Btu
1991 cost for electricity:  0.044 $/kW-hr

Annual Facility Output: 852,120 thousand lb steam
Annual #6 Fuel Oil Usage: 7,463 10^3 gal
Heating plant efficiency: 87.8% #6 fuel oil
Year of Study: 1991
Years of Operation: 1995 - 2019

*******************************************************************************
   Facility Capital Costs
*******************************************************************************
```

Equipment		Cost	Equipment		Cost
Boiler:	$	1,673,069	Stack:	$	32,911
Building/service:	$	1,377,326	Water trtmnt:	$	909,326
Feedwtr pmps:	$	31,154	Cond xfr pmps:	$	32,200
Cond strg tnk:	$	8,362	Oil (long) storage:	$	340,749
Oil day strg pmp:	$	5,015	Oil heaters:	$	8,880
Oil day strg tanks:	$	22,120	Oil unload pumps:	$	13,791
Oil xfr pmps:	$	6,425	Fire protection:	$	52,241
Cont bldn tnk:	$	1,175	Intr bldn tnk:	$	1,175
Compressor:	$	24,453	Car puller:	$	20,896
Rail:	$	22,202	Site preparation:	$	5,145
Site improvements:	$	235,085	Mobile equipment:	$	40,748
Elec substation:	$	71,237	Electrical:	$	197,854
Piping:	$	1,121,176	Instrumentation:	$	414,552
Direct costs:	$	2,458,250			

Table 55 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 2
File: FPIC6   Type: New plant (NP)   05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

****
Facility Capital Costs, cont
****

Plant installed cost: $ 10,622,206

****
Facility Annual O & M and Energy Costs
****

Operating staff: 11
Annual Labor Costs: $ 463,732
Annual Year Non-Labor O & M Costs : $ 714,017
1995 #6 fuel oil costs : $ 4,343,856
1995 Auxiliary Energy Costs : $ 72,323

****
Periodic Major Maintenance Cost Summary
****

Time Interval	Cost	Time Interval	Cost
3 years	$ 30,000	5 years	$ 6,545
10 years	$ 380,276	15 years	$ 112,846
18 years	$ 12,880	20 years	$ 14,981

****
Facility Life Cycle Cost Summary
****

Analysis using #6 fuel oil as primary fuel

+ PV 'Adjusted' Investment Costs	= $ 9,308,203
+ PV Energy + Transportation Costs	= $ 83,903,376
+ PV Annually Recurring O&M Costs	= $ 9,261,152
+ PV Non-Annually Recurring Repair & Replacement	= $ 551,423
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1991)	= $ 103,024,156

Levelized Cost of Service (1995 start) = 8.1325 $/MMBtu
Levelized Cost of Service (1995 start) = 9.7233 $/1000 lb steam

****
Sensitivity Analysis
****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	41,439,417	61,584,739	5.812
60%	49,727,300	69,872,622	6.594

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 3
File: FPIC6 Type: New plant (NP) 05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

****

Sensitivity Analysis, cont

****

80%	66,303,067	86,448,389	8.158
90%	74,590,950	94,736,272	8.941
100%	82,878,834	103,024,156	9.723
110%	91,166,717	111,312,039	10.505
120%	99,454,600	119,599,922	11.287
130%	107,742,484	127,887,806	12.069
140%	116,030,367	136,175,689	12.852
150%	124,318,251	144,463,573	13.634

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	58,798,827	78,944,149	7.450
-2%	65,677,509	85,822,831	8.099
-1%	73,639,648	93,784,970	8.851
0%	82,878,834	103,024,156	9.723
1%	93,624,768	113,770,090	10.737
2%	106,150,028	126,295,350	11.919
3%	120,778,068	140,923,390	13.300
4%	137,892,685	158,038,007	14.915
5%	157,949,203	178,094,525	16.808
6%	181,487,690	201,633,012	19.029

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	819,634	102,819,247	9.703
90%	922,088	102,921,701	9.713
100%	1,024,542	103,024,156	9.723
110%	1,126,997	103,126,610	9.732
120%	1,229,451	103,229,064	9.742

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	4,820,558	101,819,016	9.609
90%	5,423,128	102,421,586	9.666
100%	6,025,698	103,024,156	9.723
110%	6,628,268	103,626,726	9.780
120%	7,230,838	104,229,295	9.837

=== O&M non-labor cost variation ===

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	2,588,362	102,377,065	9.662
90%	2,911,908	102,700,610	9.692
100%	3,235,453	103,024,156	9.723
110%	3,558,999	103,347,701	9.753

Table 55 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 4
File: FPIC6 Type: New plant (NP) 05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

Sensitivity Analysis, cont

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	441,138	102,913,871	9.712
90%	496,281	102,969,013	9.718
100%	551,423	103,024,156	9.723
110%	606,565	103,079,298	9.728
120%	661,708	103,134,440	9.733

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	7,446,562	100,948,540	9.527
90%	8,377,382	101,986,348	9.625
100%	9,308,203	103,024,156	9.723
110%	10,239,023	104,061,964	9.821
120%	11,169,843	105,099,771	9.919

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-252,951	103,277,107	9.747
-10%	-168,634	103,192,790	9.739
-5%	-84,317	103,108,473	9.731
0%	0	103,024,156	9.723
5%	84,317	102,939,838	9.715
10%	168,634	102,855,521	9.707
15%	252,951	102,771,204	9.699

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	199,968,565	18.872
0.5%	184,460,696	17.409
1.5%	157,811,232	14.894
2.5%	135,970,824	12.832
3.5%	117,962,622	11.133
4.5%	103,024,156	9.723
5.5%	90,557,498	8.546
6.5%	80,091,571	7.558
7.5%	71,253,500	6.724
8.5%	63,746,775	6.016

Table 55 (Cont'd)

```
Central Heating Plant Economics Evaluation -- Sensitivity Analysis      Page 5
File: FPIC6        Type: New plant (NP)                                05/13/92
Desc: PICATINNY ARSENAL
Tech: Gas / Oil Fired Boiler

******************************************************************************
   Sensitivity Analysis, cont
******************************************************************************

       10.5%             51,826,582            4.891
       11.5%             47,069,696            4.442
       12.0%             44,933,127            4.240

=== Plant life variation ===
------------------------------------------------------------------------------
      Change         Life Cycle Cost  LCS,$/1000lb steam
       10 yr             52,846,076            9.346
       11 yr             56,862,494            9.330
       12 yr             60,808,168            9.332
       13 yr             64,644,285            9.343
       14 yr             68,375,409            9.360
       15 yr             72,075,701            9.392
       16 yr             75,611,504            9.419
       17 yr             79,035,784            9.447
       18 yr             82,376,400            9.480
       19 yr             85,601,633            9.512
       20 yr             88,876,815            9.561
       21 yr             91,909,008            9.595
       22 yr             94,826,807            9.627
       23 yr             97,650,242            9.659
       24 yr            100,385,181            9.691
       25 yr            103,024,156            9.723
```

Table 56

Cost Sensitivity Analysis for a Coal-Fired Stoker Plant

```
Central Heating Plant Economics Evaluation -- Sensitivity Analysis      Page 1
File: FPICC          Type: New plant (NP)                              05/13/92
Desc: PICATINNY ARSENAL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

*****************************************************************************
   Base and Plant Information
*****************************************************************************

State: NJ - New Jersey             Base DOE Region: 1
PMCR: 250,000 lb/hr steam      Number of boilers: 4

Coal code: W190581                         Distance from base:   287 miles
State: PA - Pennsylvania                   DOE Region:  1
Coal type: bituminous                 (properties on a dry basis)
     hhv: 11970 Btu/lb    fixed carbon:  54.50%    volatiles:  36.10%
     ash:    9.40%    sulfur:    1.80%

Coal handling equipment capacity: 150 tons/hr
Coal silo storage capacity: 1015 tons
Approx. building width: 72 feet
Approx. building length: 211 feet
Height of the plant: 76 ft
Building area: 15125 sq ft
Plant area: 2.02 acres

*****************************************************************************
   Facility Parameters
*****************************************************************************

Capital Equipment Escalation Factor:  1.045 (4771.57/1991)
Non-Labor Operation & Maintenance Escalation Factor:  1.106 ( 947.10/1991)
Operation & Maintenance Labor Escalation Factor:  1.061 (4386.55/1991)
Construction Labor Escalation Factor:  1.030 ( 272.70/1991)

Annual diesel/distillate fuel usage: 17,000 gallons
Annual electricity usage: 5,531,268 kW-hr
Annual lime usage: 3,352 tons

1991 cost for coal:  1.754 $/MMBtu
1991 cost for distillate:  0.662 $/gallon
1991 cost for electricity:  0.044 $/kW-hr

Annual Facility Output: 852,120 thousand lb steam
Annual Coal Usage: 48,059 tons (dry)  /  53,730 tons (wet)
Heating plant efficiency: 84%
Year of Study: 1991
Years of Operation: 1995 - 2019

*****************************************************************************
   Facility Installed Capital Costs
*****************************************************************************
```

Equipment		Cost	Equipment		Cost
Boiler:	$	15,459,897	Coal Handling:	$	6,995,254
Ash Handling:	$	4,931,886	Mechncl Collector:	$	201,195

Table 56 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 2
File: FPICC Type: New plant (NP) 05/13/92
Desc: PICATINNY ARSENAL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****

Facility Installed Capital Costs, cont

****

Water Treatment:	$	1,711,718	Pumps:	$	320,821
Air Compressor:	$	103,275	Waste Water Trtmnt:	$	174,671
Piping/Stack:	$	6,440,614	Electrical System:	$	2,115,710
Building Costs:	$	8,586,528	Direct costs:	$	16,053,338

****

Plant installed cost: $ 74,382,847

****

Facility Annual O & M and Energy Costs

****

Operating staff: 30
Annual Labor Costs: $ 1,275,617

First Year Non-Labor O & M Costs	: $	2,273,942
Annual Year Non-Labor O & M Costs	: $	2,674,165
1995 Coal Costs (incl transport)	: $	2,640,889
1995 Auxiliary Energy Costs	: $	258,184

****

Periodic Major Maintenance Cost Summary

****

Time Interval		Cost	Time Interval		Cost
3 years	$	122,066	5 years	$	110,411
7 years	$	120,998	8 years	$	344,326
10 years	$	884,094	12 years	$	66,148
15 years	$	17,057	18 years	$	25,758
20 years	$	942,820			

****

Facility Life Cycle Cost Summary

****

+ PV 'Adjusted' Investment Costs	= $	65,181,437
+ PV Energy + Transportation Costs	= $	41,661,389
+ PV Annually Recurring O&M Costs	= $	34,412,248
+ PV Non-Annually Recurring Repair & Replacement	= $	2,634,990
+ PV Disposal Cost of Existing System	= $	0
+ PV Disposal Cost of New/Retrofit Facility	= $	0
Total Life Cycle Cost (1991)	= $	143,890,065

Levelized Cost of Service (1995 start) = 11.358 $/MMBtu

Table 56 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis Page 3
File: FPICC Type: New plant (NP) 05/13/92
Desc: PICATINNY ARSENAL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****

Sensitivity Analysis

****

=== Primary fuel initial cost variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
50%	18,980,482	124,909,582	11.788
60%	22,776,579	128,705,679	12.147
70%	26,572,676	132,501,775	12.505
80%	30,368,772	136,297,872	12.863
90%	34,164,869	140,093,969	13.221
100%	37,960,965	143,890,065	13.580
110%	41,757,062	147,686,162	13.938
120%	45,553,159	151,482,258	14.296
130%	49,349,255	155,278,355	14.655
140%	53,145,352	159,074,452	15.013
150%	56,941,448	162,870,548	15.371

=== Primary fuel escalation rate variation ===

Change	PV Primary Fuel	Life Cycle Cost	LCS,$/1000lb steam
-3%	27,518,797	133,447,897	12.594
-2%	30,513,820	136,442,920	12.877
-1%	33,967,490	139,896,589	13.203
0%	37,960,965	143,890,065	13.580
1%	42,590,495	148,519,595	14.017
2%	47,970,235	153,899,335	14.524
3%	54,235,592	160,164,691	15.116
4%	61,547,168	167,476,268	15.806
5%	70,095,436	176,024,536	16.613
6%	80,106,247	186,035,347	17.557

=== Auxiliary energy cost variation ===

Change	PV Auxiliary Energy	Life Cycle Cost	LCS,$/1000lb steam
80%	2,960,338	143,149,981	13.510
90%	3,330,381	143,520,023	13.545
100%	3,700,423	143,890,065	13.580
110%	4,070,465	144,260,108	13.615
120%	4,440,508	144,630,150	13.650

=== O&M labor cost variation ===

Change	PV O&M Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	13,260,202	140,575,015	13.267
90%	14,917,728	142,232,540	13.423
100%	16,575,253	143,890,065	13.580
110%	18,232,778	145,547,591	13.736
120%	19,890,304	147,205,116	13.893

=== O&M non-labor cost variation ===

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 4
File: FPICC   Type: New plant (NP)   05/13/92
Desc: PICATINNY ARSENAL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Sensitivity Analysis, cont
****

Change	PV O&M Non-Labor	Life Cycle Cost	LCS,$/1000lb steam
80%	14,269,596	140,322,666	13.243
90%	16,053,295	142,106,366	13.411
100%	17,836,995	143,890,065	13.580
110%	19,620,694	145,673,765	13.748
120%	21,404,394	147,457,464	13.916

=== Repair/replace cost variation ===

Change	PV Repair/Replace	Life Cycle Cost	LCS,$/1000lb steam
80%	2,107,992	143,363,067	13.530
90%	2,371,491	143,626,566	13.555
100%	2,634,990	143,890,065	13.580
110%	2,898,489	144,153,564	13.605
120%	3,161,989	144,417,063	13.629

=== Initial cost variation ===

Change	PV Initial Cost	Life Cycle Cost	LCS,$/1000lb steam
80%	52,145,149	128,695,841	12.146
90%	58,663,293	136,292,953	12.863
100%	65,181,437	143,890,065	13.580
110%	71,699,580	151,487,178	14.297
120%	78,217,724	159,084,290	15.014

=== Existing salvage value variation ===

Change	PV Existing Salvage	Life Cycle Cost	LCS,$/1000lb steam

Existing plant salvage values specified is 0.
Variation of value is unnecessary. Analysis skipped.

=== New salvage value variation ===

Change	PV New Salvage	Life Cycle Cost	LCS,$/1000lb steam
-15%	-1,640,928	145,530,994	13.735
-10%	-1,093,952	144,984,018	13.683
-5%	-546,976	144,437,041	13.631
0%	0	143,890,065	13.580
5%	546,976	143,343,089	13.528
10%	1,093,952	142,796,113	13.476
15%	1,640,928	142,249,137	13.425

=== Discount rate variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
0.0%	228,790,331	21.593
0.5%	215,623,821	20.350
1.5%	192,714,944	18.188

Table 56 (Cont'd)

Central Heating Plant Economics Evaluation -- Sensitivity Analysis   Page 5
File: FPICC   Type: New plant (NP)   05/13/92
Desc: PICATINNY ARSENAL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****
Sensitivity Analysis, cont
****

3.5%	157,516,619	14.866
4.5%	143,890,065	13.580
5.5%	132,254,362	12.482
6.5%	122,244,376	11.537
7.5%	113,569,996	10.718
8.5%	105,999,566	10.004
9.5%	99,347,178	9.376
10.5%	93,462,882	8.820
11.5%	88,225,121	8.326
12.0%	85,816,994	8.099

=== Plant life variation ===

Change	Life Cycle Cost	LCS,$/1000lb steam
10 yr	105,456,941	18.651
11 yr	108,625,896	17.823
12 yr	111,773,064	17.154
13 yr	114,710,661	16.579
14 yr	117,593,683	16.098
15 yr	120,424,534	15.692
16 yr	123,191,953	15.346
17 yr	125,714,265	15.027
18 yr	128,202,981	14.754
19 yr	130,544,299	14.507
20 yr	133,504,147	14.363
21 yr	135,762,379	14.173
22 yr	137,857,000	13.996
23 yr	139,875,524	13.836
24 yr	141,983,064	13.707
25 yr	143,890,065	13.580

Table 57

Summary of Coal Conversion Potential for the Four Bases Studied

Parameters	Values for: Fort Gordon	Fort Campbell	Picatinny	Fort Bragg
New plant PMCR (1000 LBS/HR)	100	188	250	379
Base location				
DOE FY91 price	DOE REG.3	DOE REG.3	DOE REG.1	DOE REG.3
Elec.($/MBtu)	15.35	15.35	13.12	15.35
Gas ($/MBtu)	2.69	2.69	4.11	2.69
#6 Oil($/MBtu)	2.62	2.62	2.93	2.62
Coal($/MBtu)	1.71	1.53	1.75	1.72
Coal Source	DOE REG.3	DOE REG.2	DOE REG.1	DOE REG.3
Breakeven price				
Gas ($/MBtu)	7.2	5.2	5.15	3.7
#6 Oil ($/MBtu)	8.1	5.8	5.18	4.1
Price paid by base				
Gas ($/MBtu)	5.5	3	3.38	4.5
#6 Oil ($/MBtu)	4.41	3.54	3.45	4.41
Price increase needed to use coal as fuel	31% (GAS) 84% (OIL)	73%(GAS) 64%(OIL)	52%(GAS) 50%(OIL)	0%(GAS) 8%(OIL)

APPENDIX B:

Figures

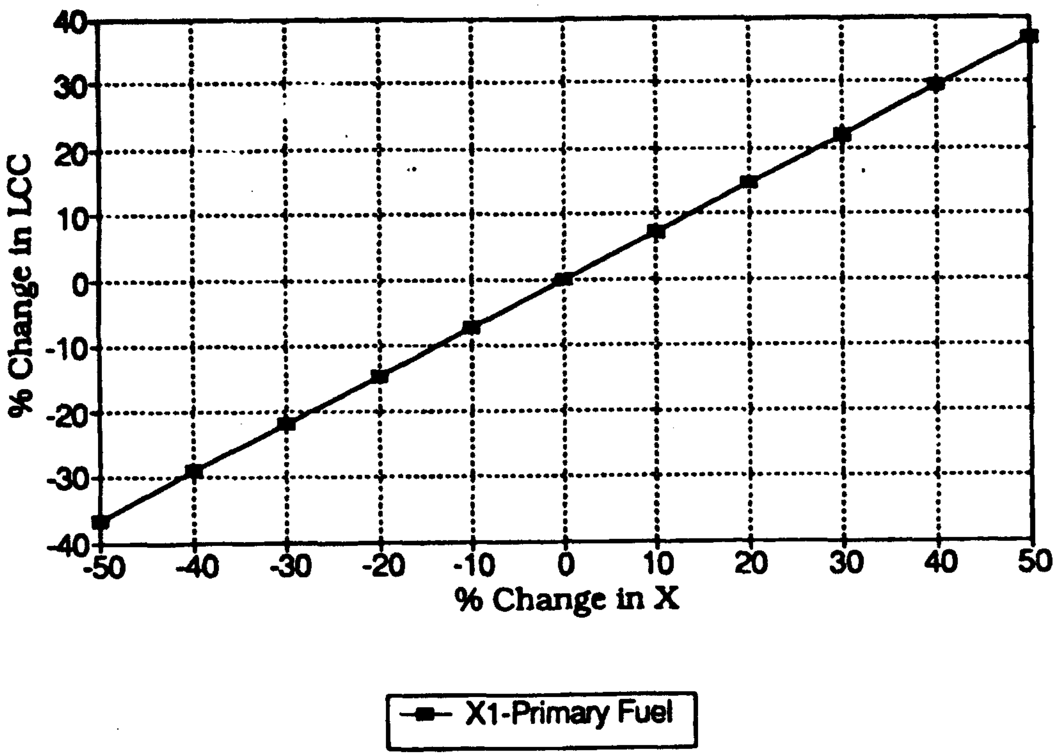

Figure 1. **Effect of Primary Fuel Price on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Campbell.**

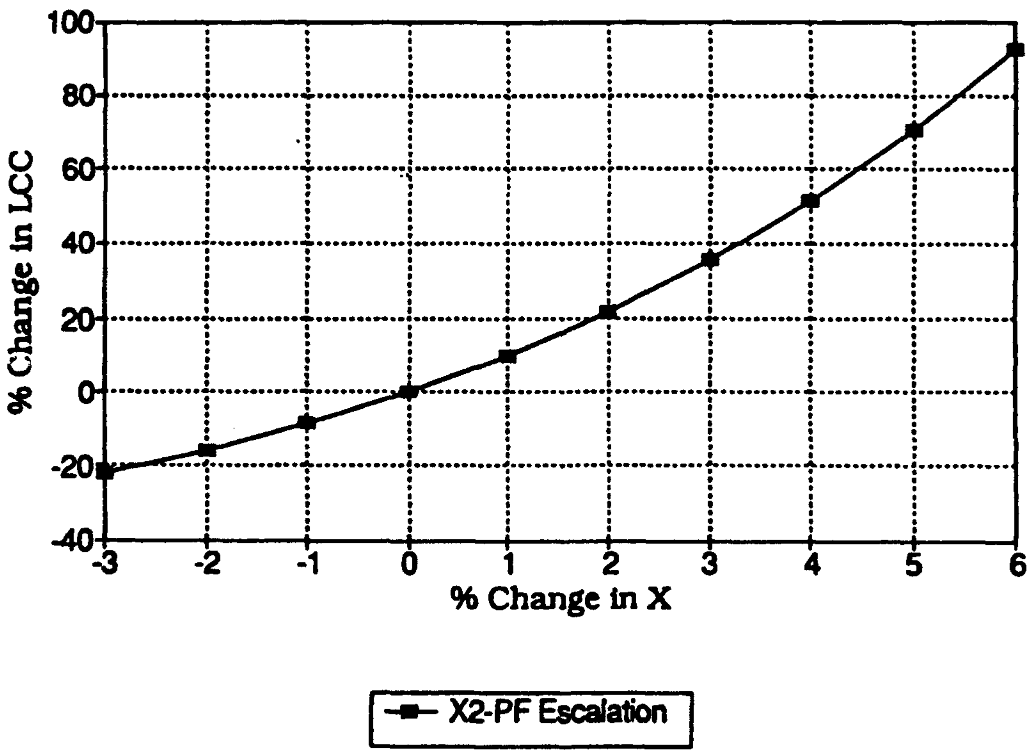

Figure 2. **Effect of Primary Fuel Cost Escalation Rate on the LCC of a Gas-/#2 Oil-Fired Boiler Plant, Fort Campbell.**

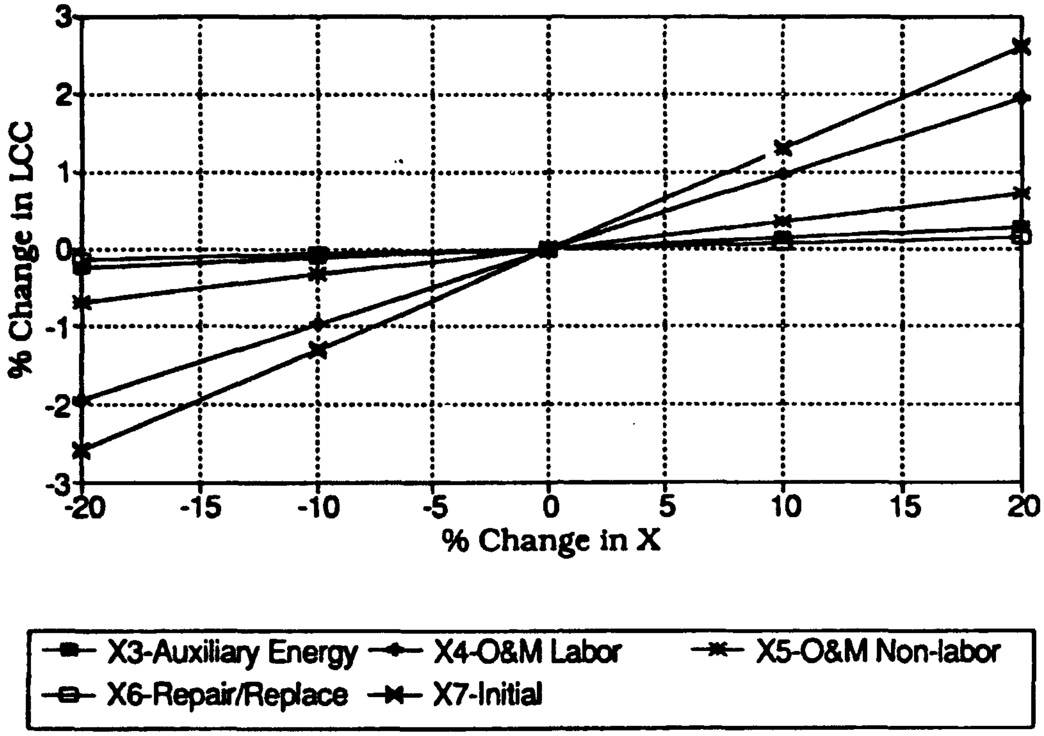

Figure 3. **Effect of Auxiliary Energy Costs, O&M Labor, O&M Non-labor, Repair/Replacement and Initial Cost on the LCC of a Gas/#2 Oil-fired Boiler Plant, Fort Campbell.**

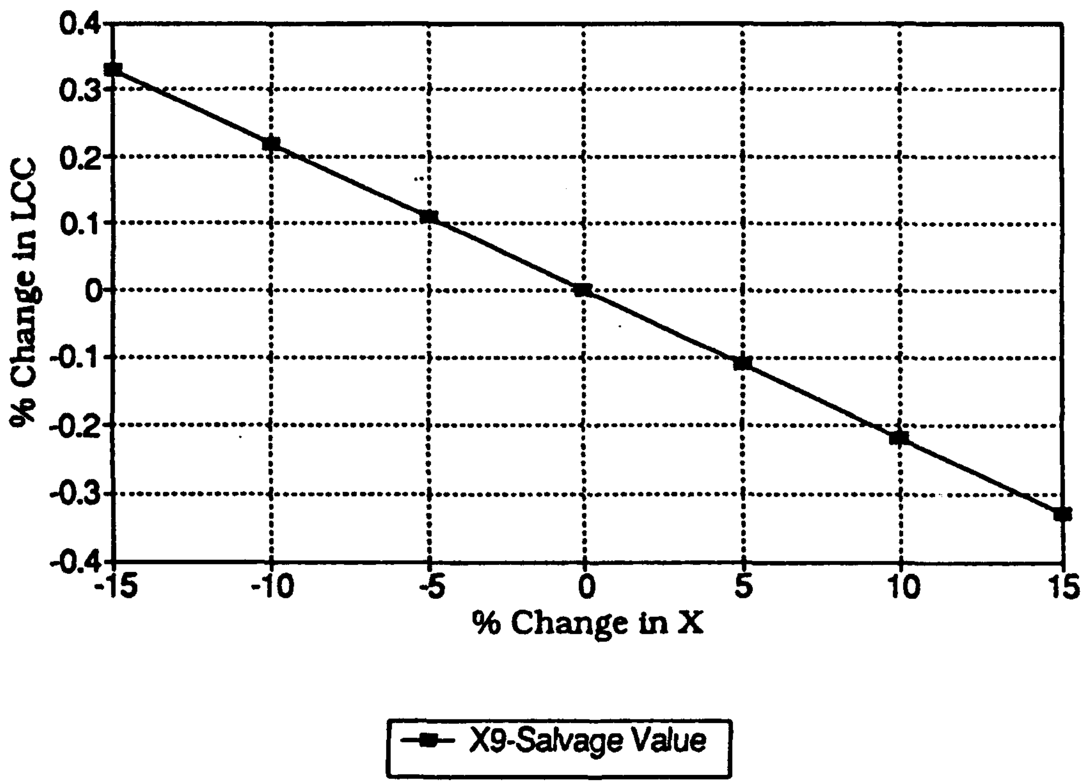

Figure 4. **Effect of Salvage Value on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Campbell.**

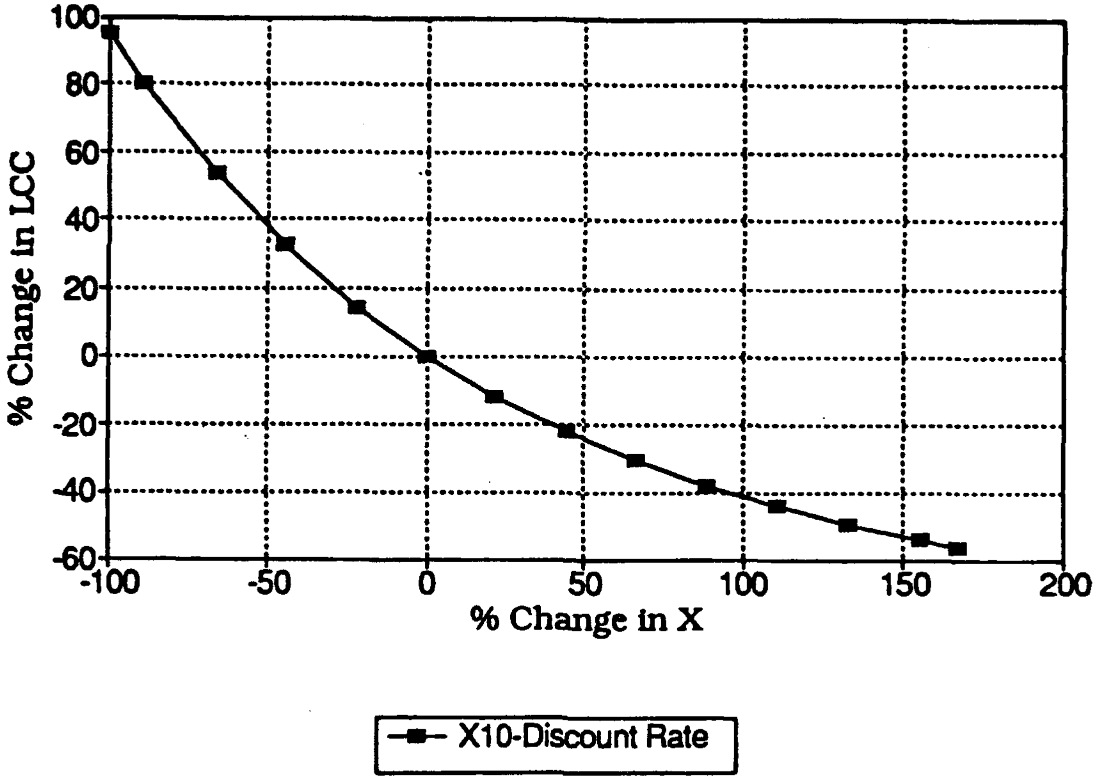

Figure 5. **Effect of Discount Rate on the LCC of a Gas/#2 Oil-Fired Plant, Fort Campbell.**

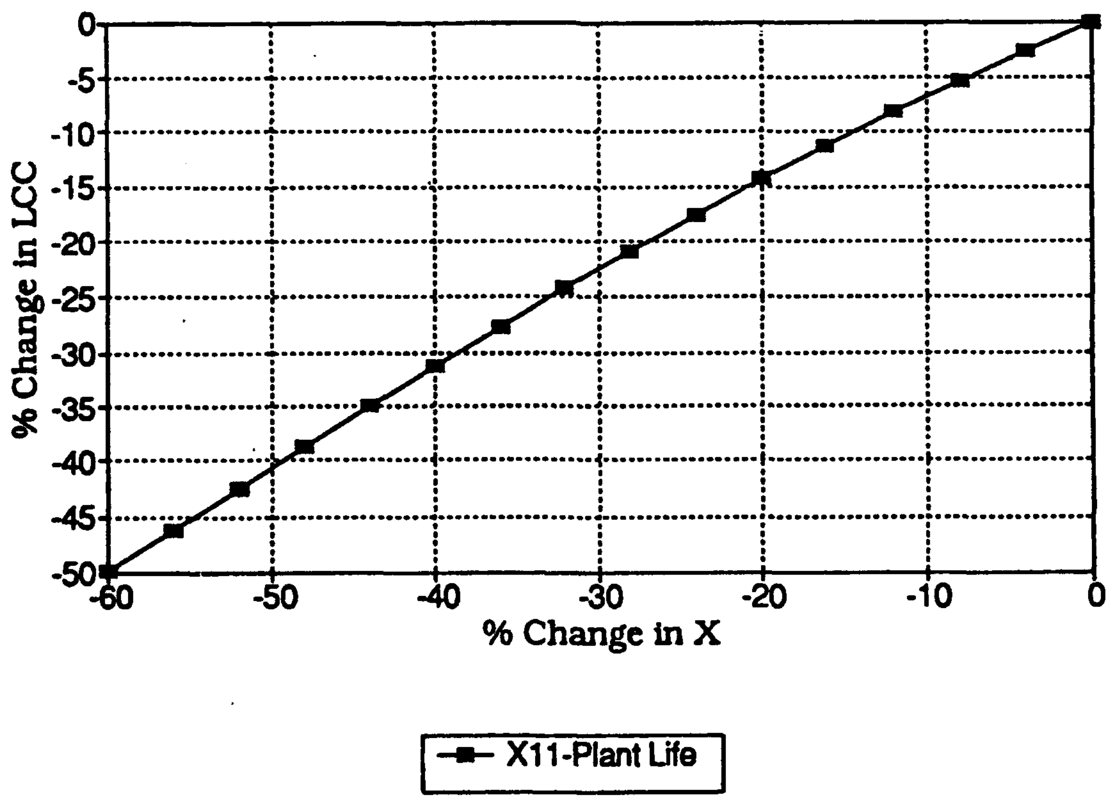

Figure 6. **Effect of Plant Life on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Campbell.**

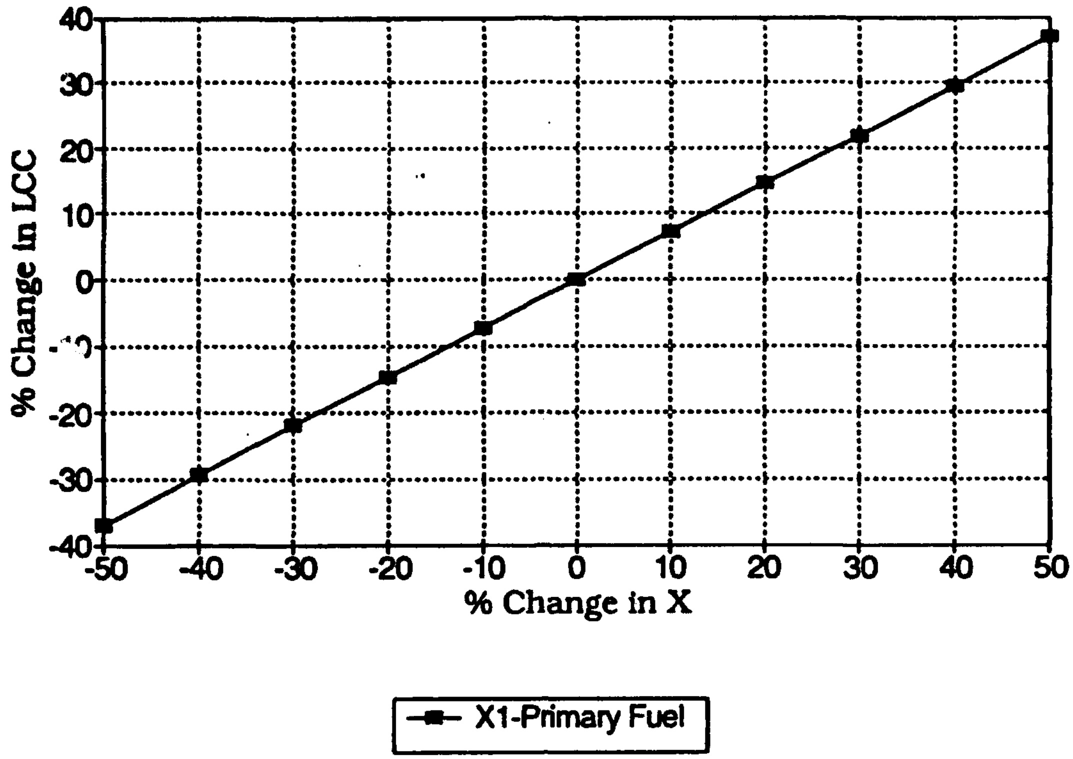

Figure 7. **Effect of Primary Fuel Price on the LCC of a #6 Oil-Fired Boiler Plant, Fort Campbell.**

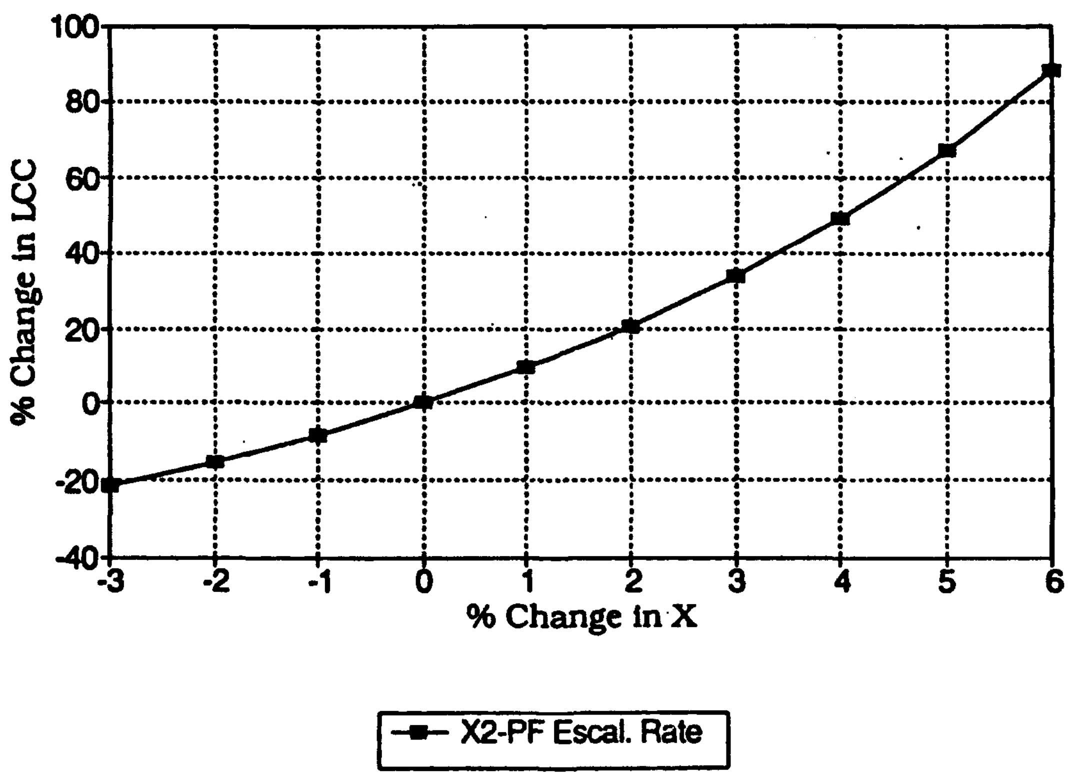

Figure 8. **Effect of Primary Fuel Escalation Rate on the LCC of a #6 Oil-Fired Boiler Plant, Fort Campbell.**

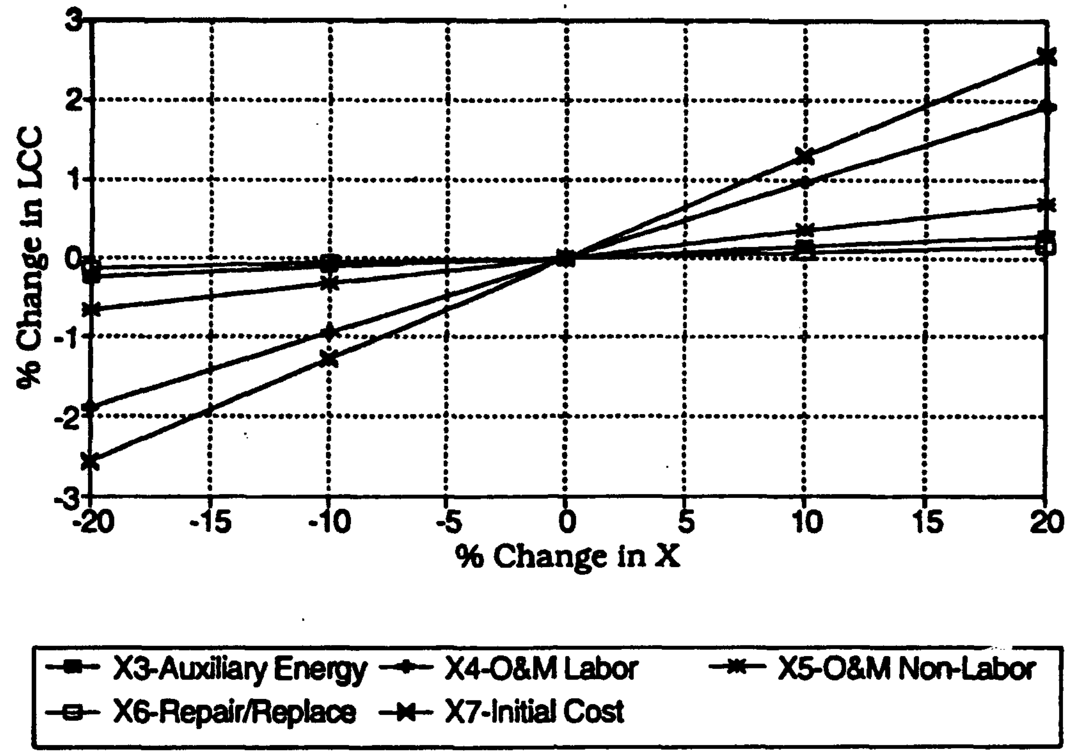

Figure 9. **Effect of Auxiliary Energy Costs, O&M Labor, O&M Non-Labor, Repair/Replacement and Initial Cost on the LCC of a #6 Oil-Fired Boiler Plant, Fort Campbell.**

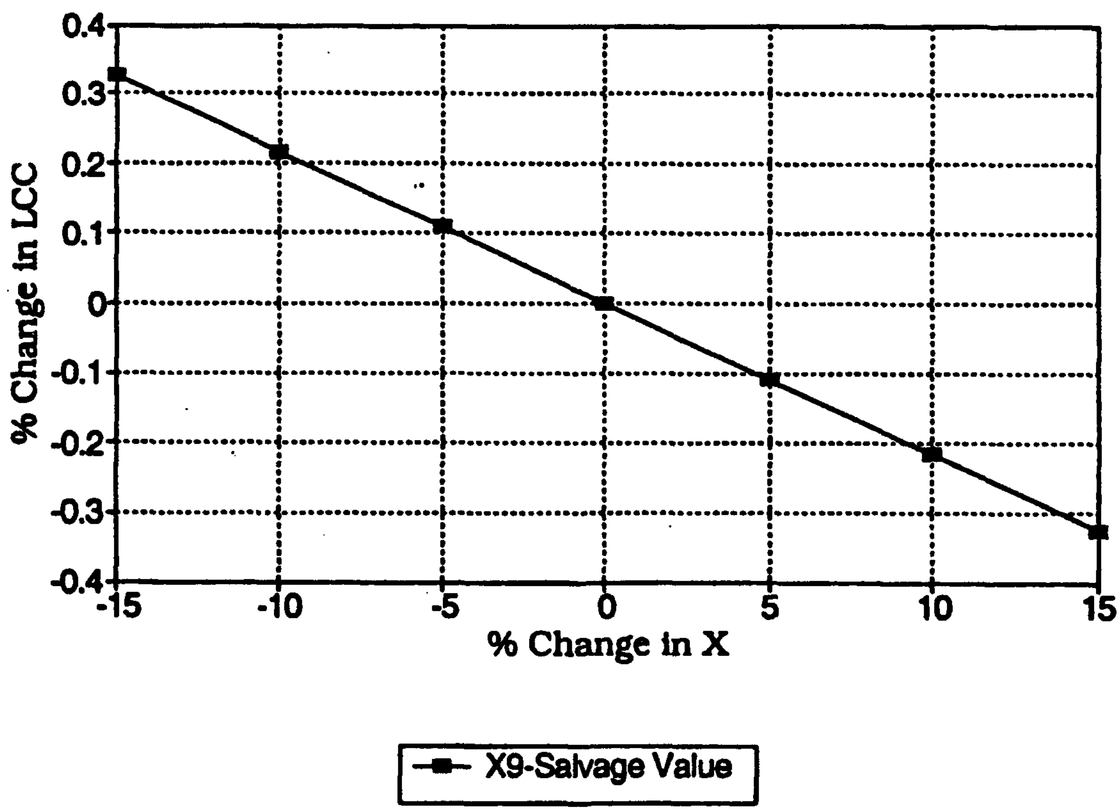

Figure 10. **Effect of Salvage Value on the LCC of a #6 Oil-Fired Boiler Plant, Fort Campbell.**

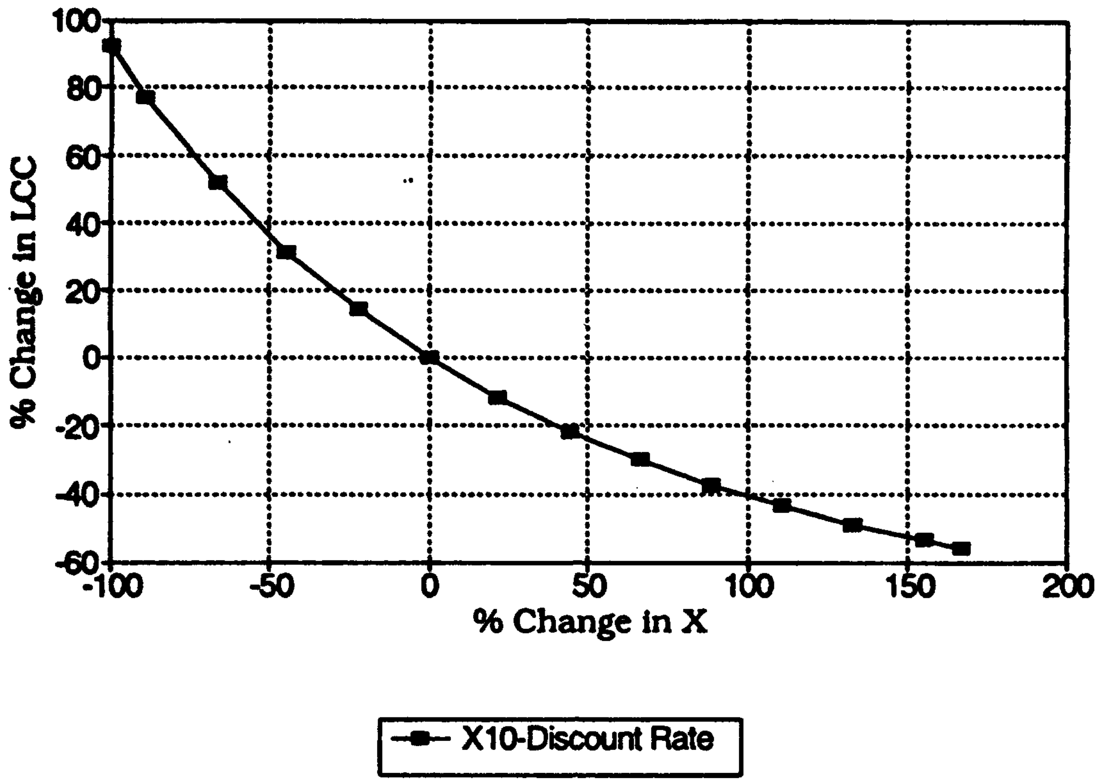

Figure 11. Effect of Discount Rate on the LCC of a #6 Oil-Fired Boiler Plant, Fort Campbell.

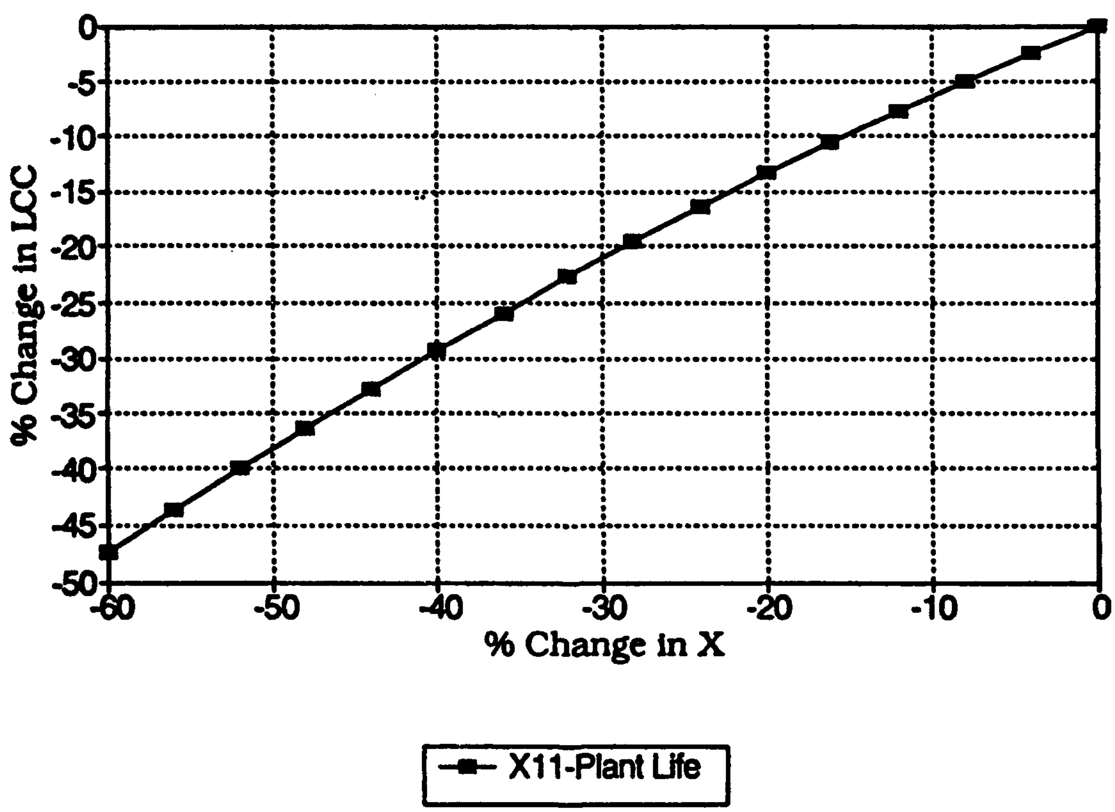

Figure 12. Effect of Plant Life on the LCC of a #6 Oil-Fired Boiler Plant, Fort Campbell.

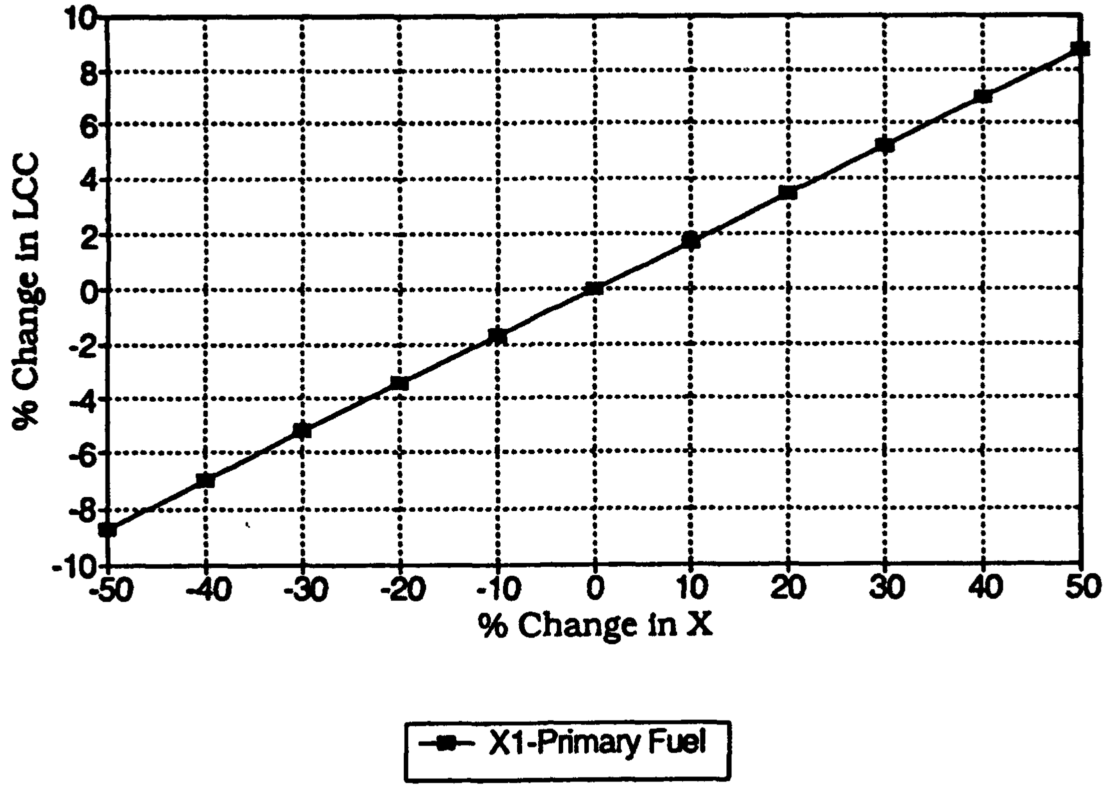

Figure 13. Effect of Primary Fuel Price on the LCC of a Coal-Fired Stoker Plant, Fort Campbell.

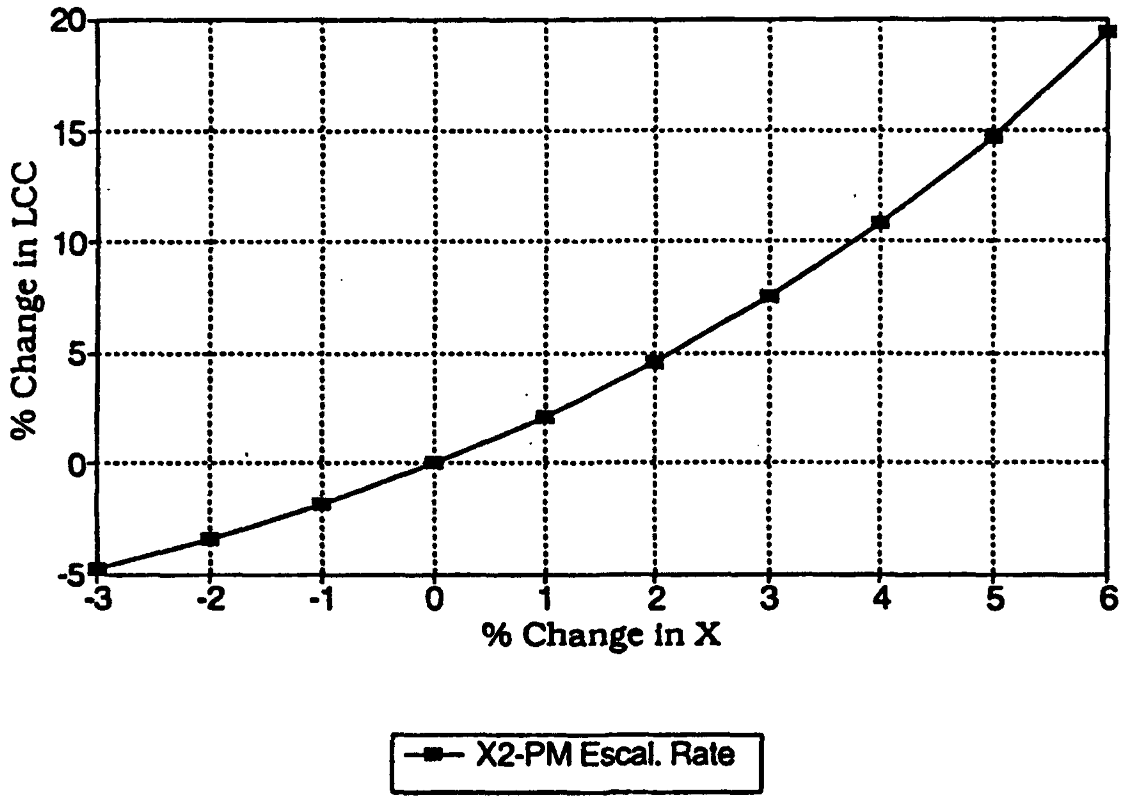

Figure 14. Effect of Escalation Rate on the LCC of a Coal-Fired Stoker Plant, Fort Campbell.

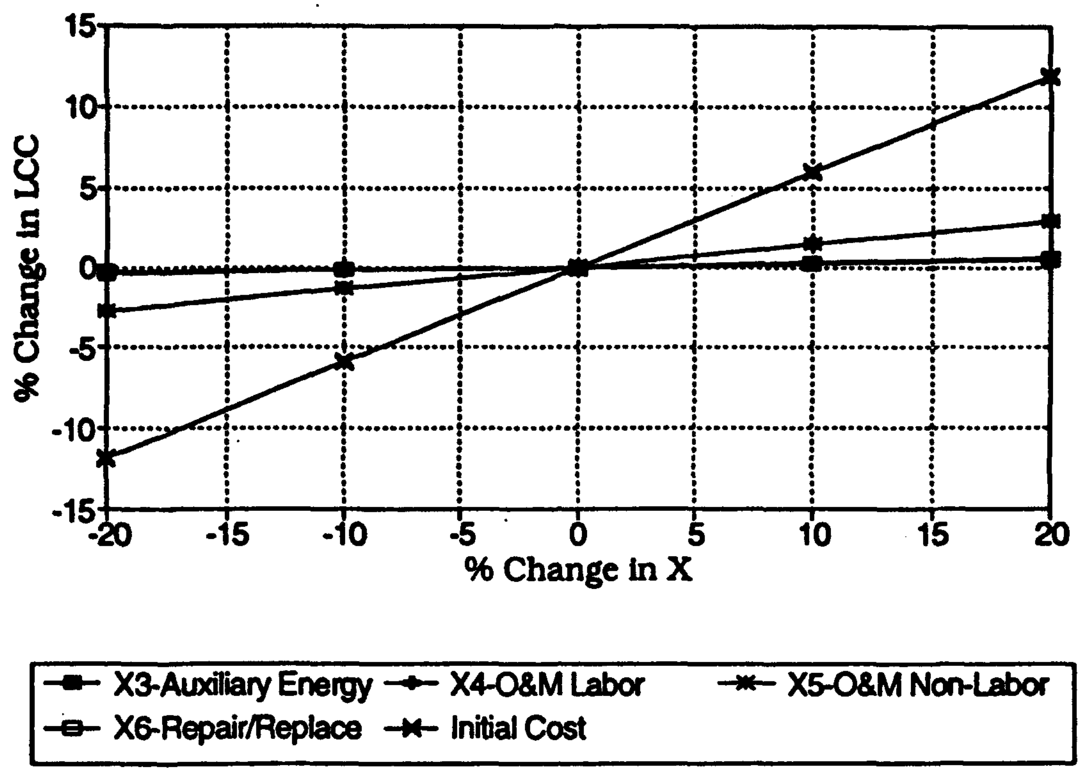

Figure 15. **Effect of Auxiliary Energy Cost, O&M Labor, O&M Non-labor, Repair/Replace and Initial Cost on the LCC of a Coal-Fired Stoker Plant, Fort Campbell .**

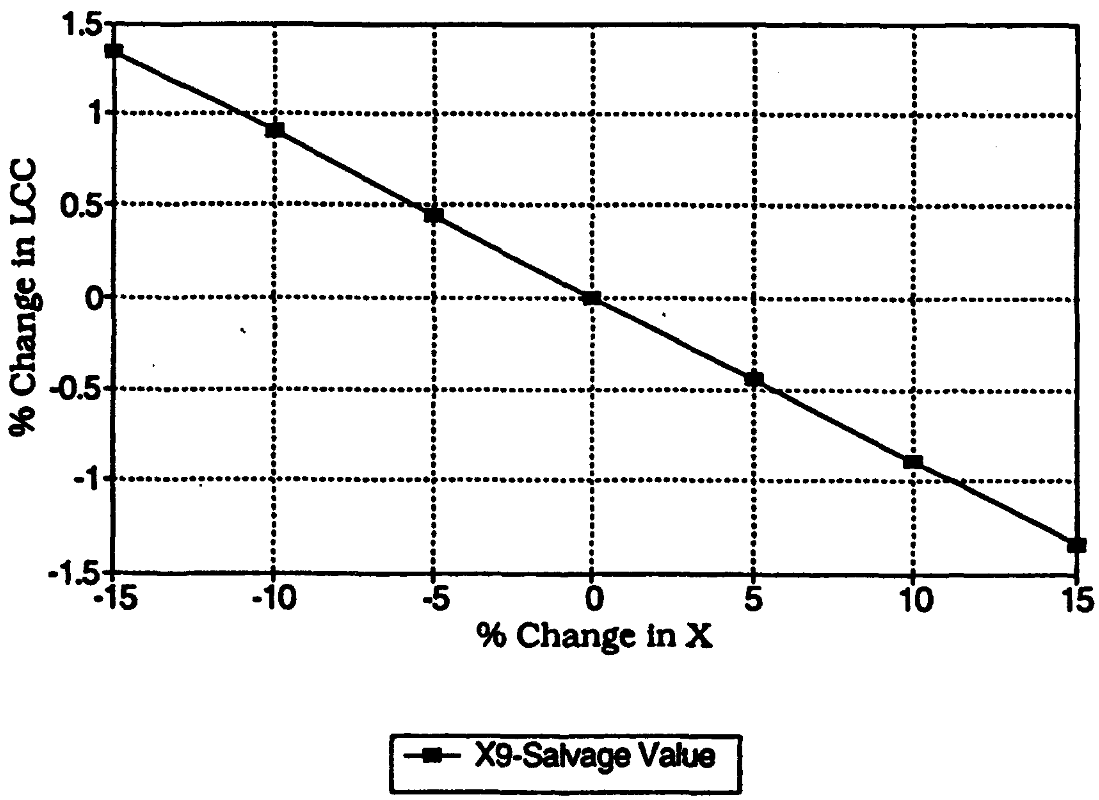

Figure 16. **Effect of Salvage Value on the LCC of a Coal-Fired Stoker Plant, Fort Campbell.**

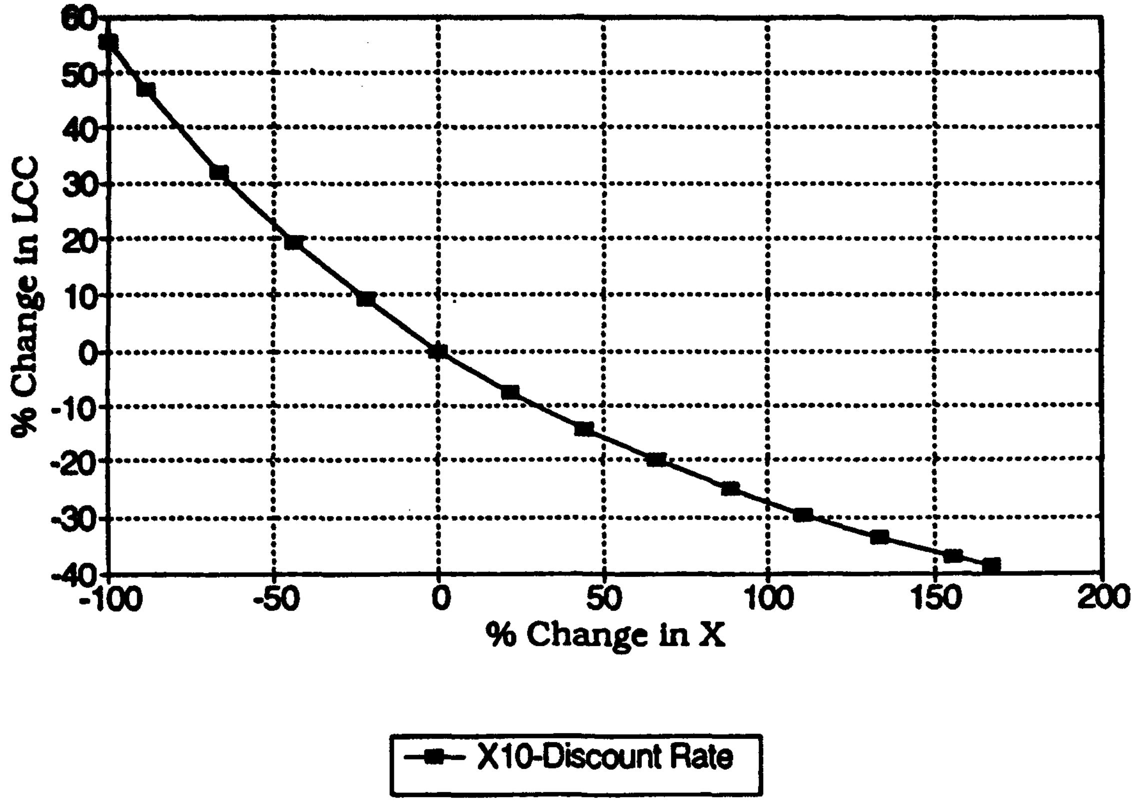

Figure 17. Effect of Discount Rate on the LCC of a Coal-Fired Stoker Plant, Fort Campbell.

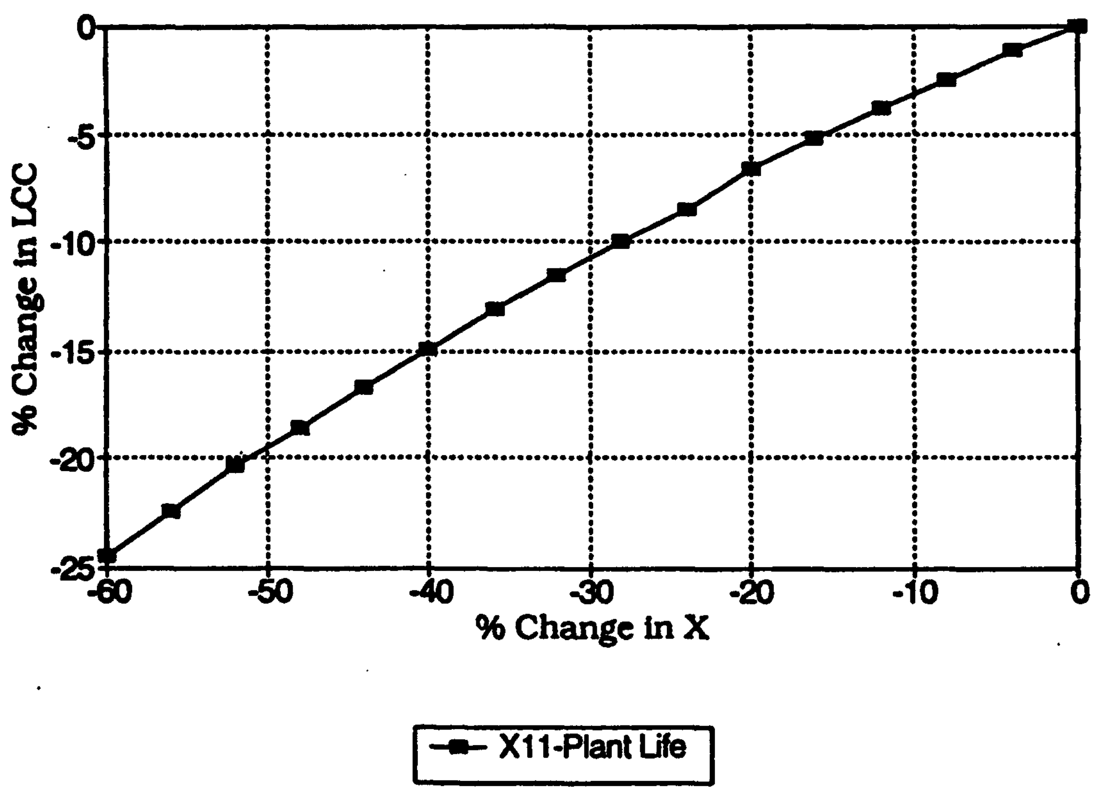

Figure 18. Effect of Plant Life on the LCC of a Coal-Fired Stoker Plant, Fort Campbell.

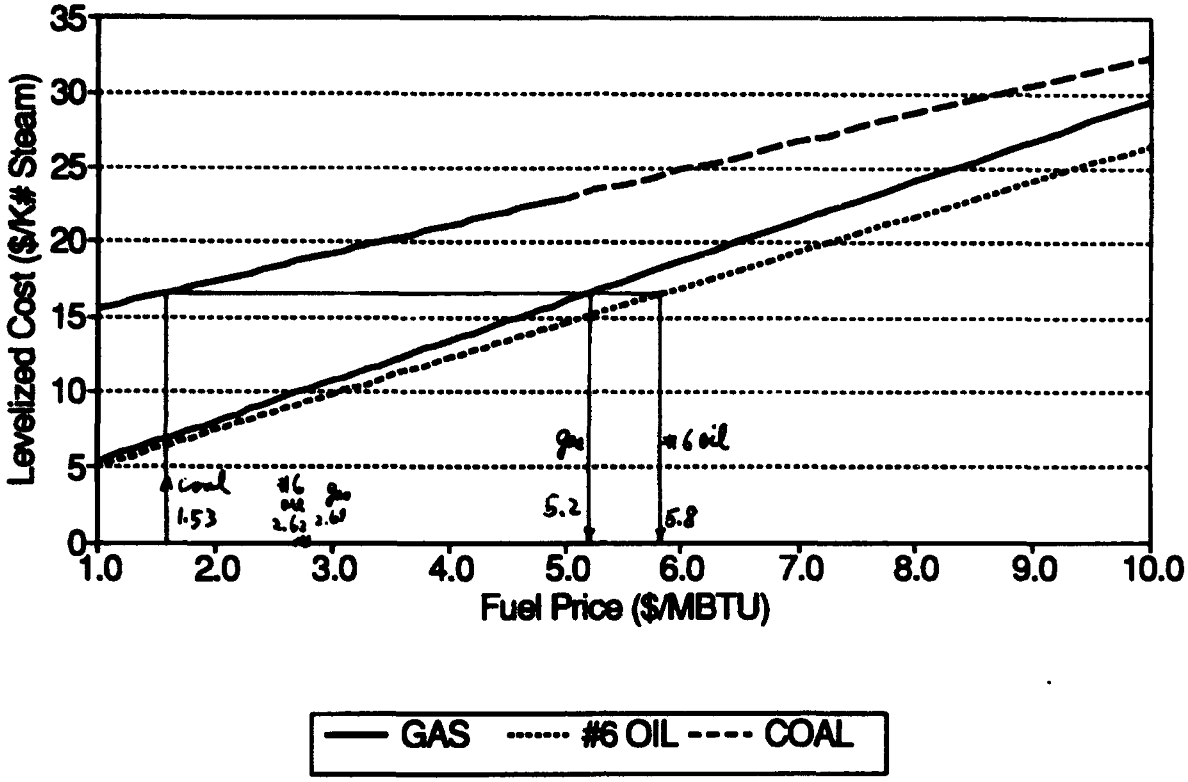

Figure 19. Leveled Cost of Service vs. Fuel Price; Fort Campbell.

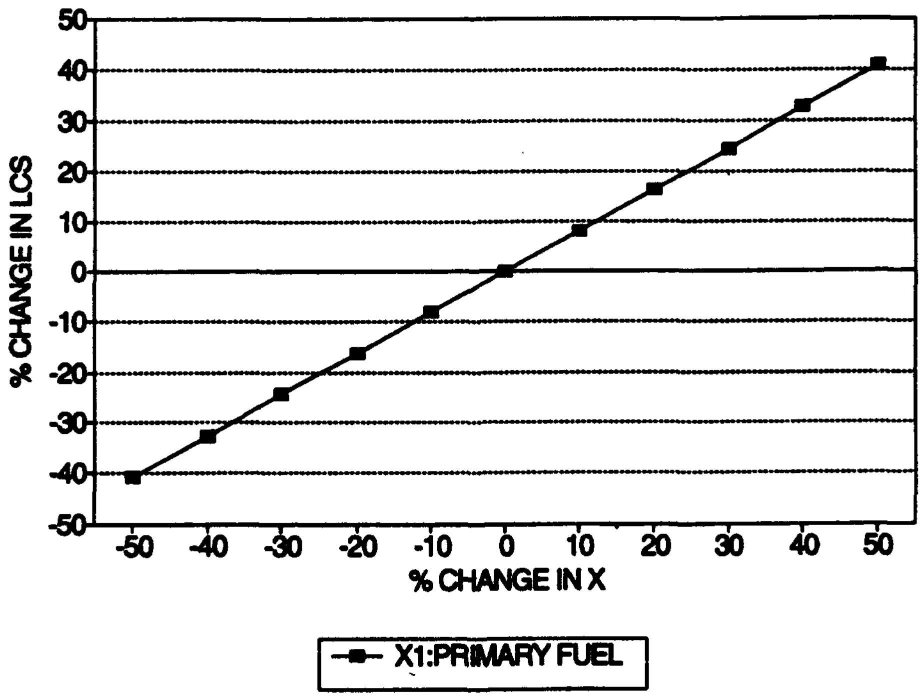

Figure 20. Effect of Primary Fuel Cost on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Bragg.

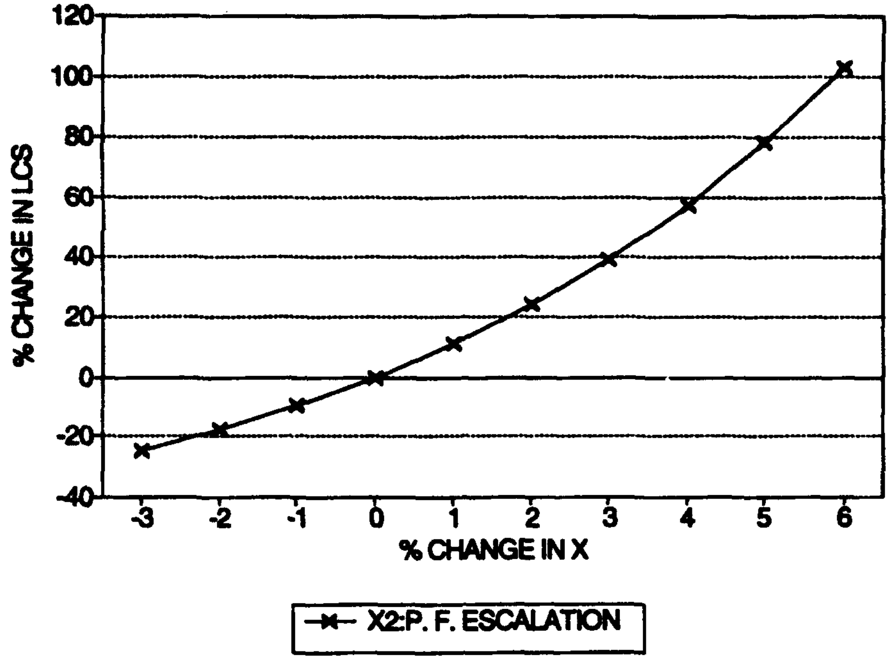

Figure 21. Effect of Primary Fuel Escalation on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Bragg.

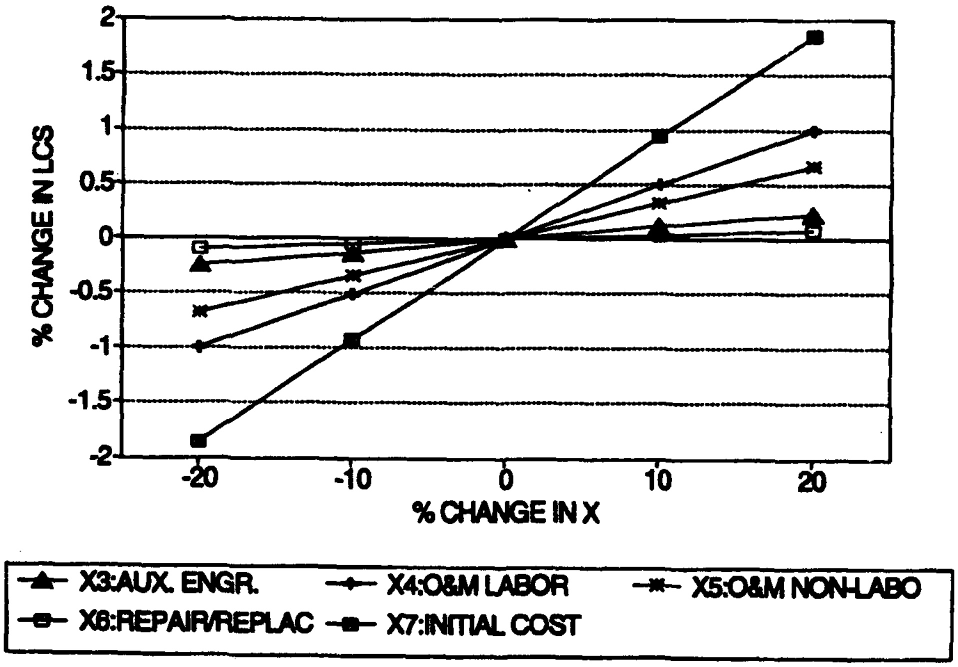

Figure 22. Effect of Auxiliary Energy, O&M Labor, O&M Non-Labor, Repair/Replacement and Initial Costs on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Bragg.

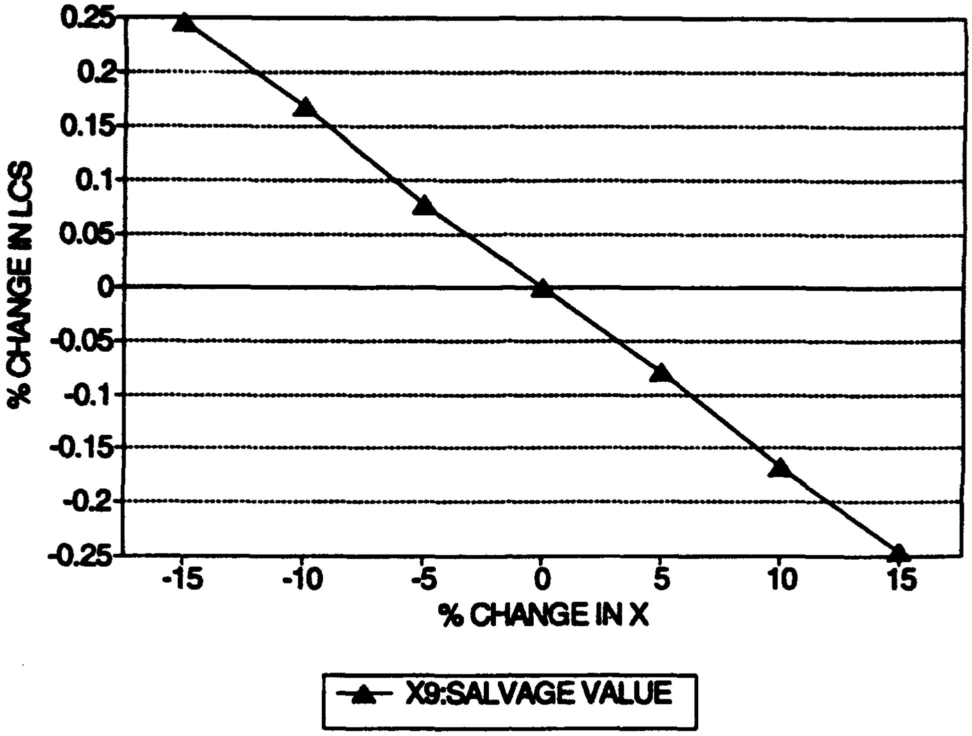

Figure 23. Effect of Salvage Value on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Bragg.

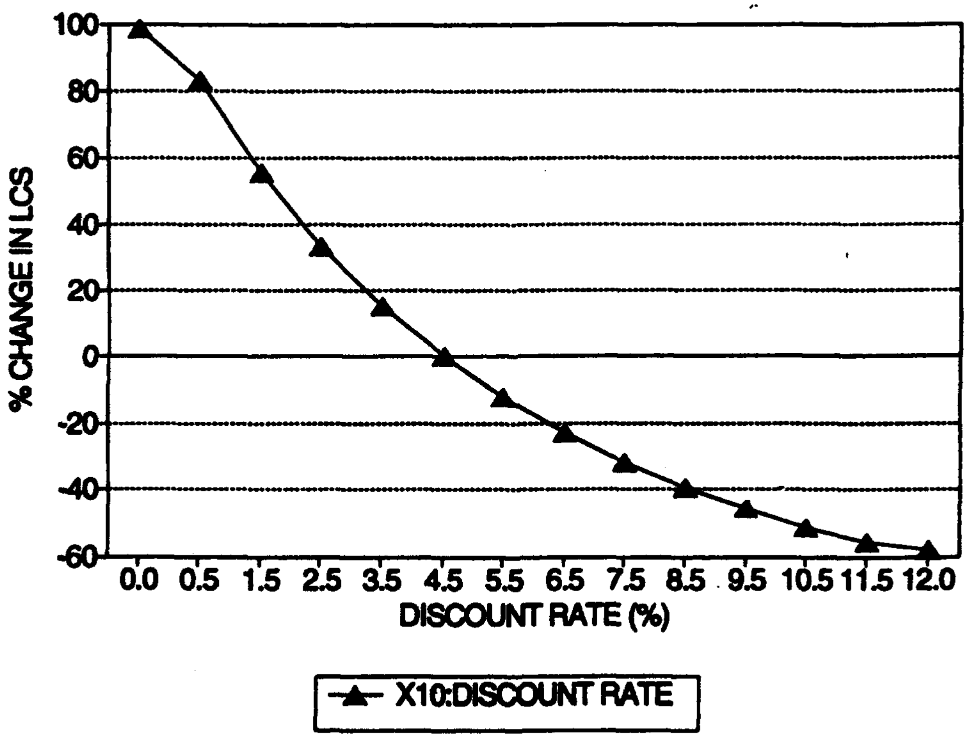

Figure 24. Effect of Discount Rate on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Bragg.

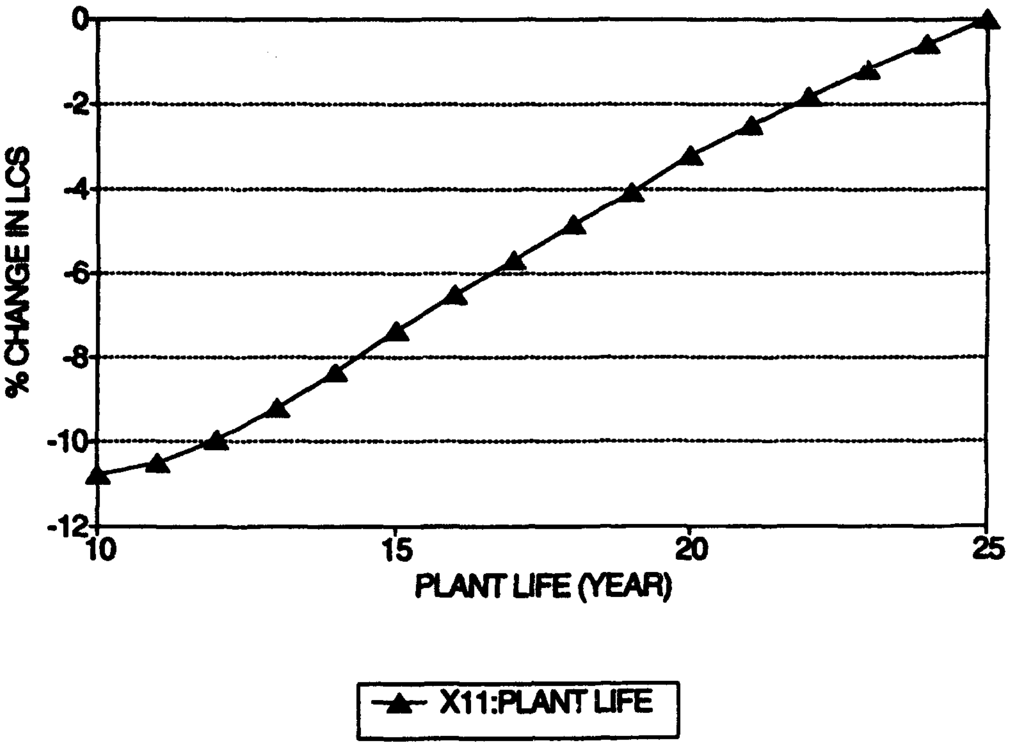

Figure 25. Effect of Plant Life on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Bragg.

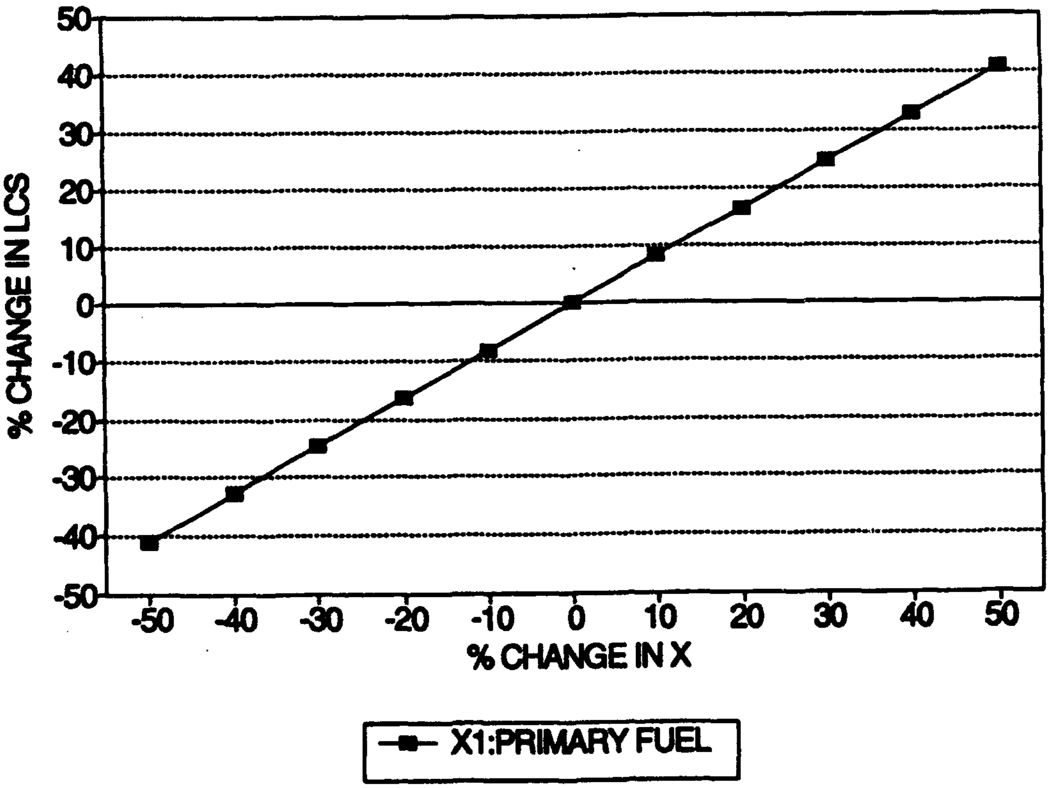

Figure 26. Effect of Primary Fuel Cost on the LCC of a #6 Oil-Fired Boiler Plant, Fort Bragg.

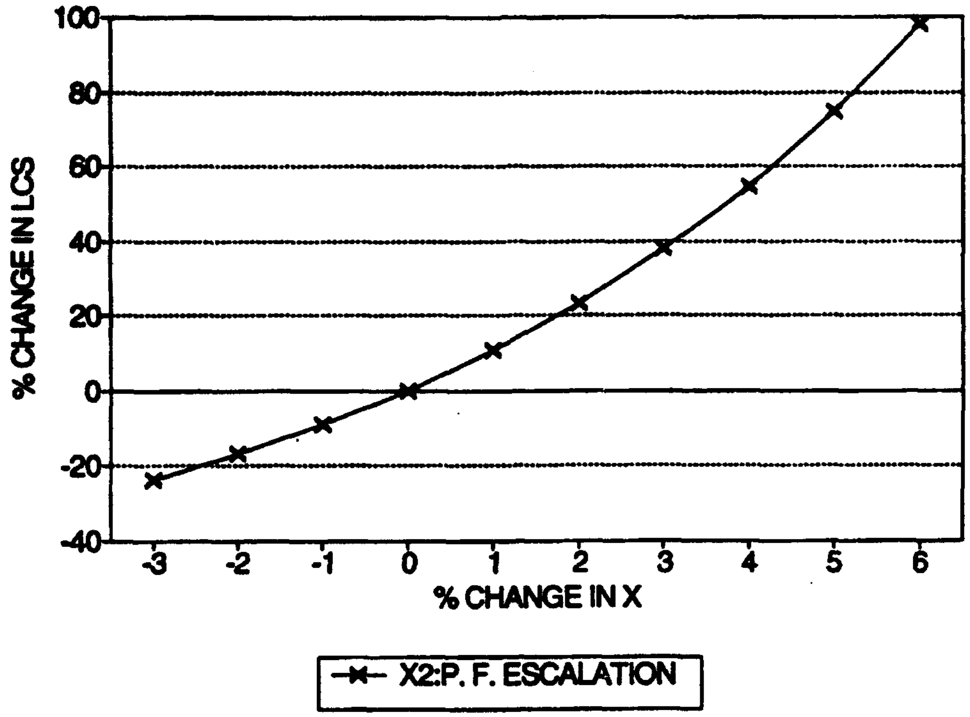

Figure 27. Effect of Primary Fuel Cost Escalation on the LCC of a #6 Oil-Fired Boiler Plant, Fort Bragg.

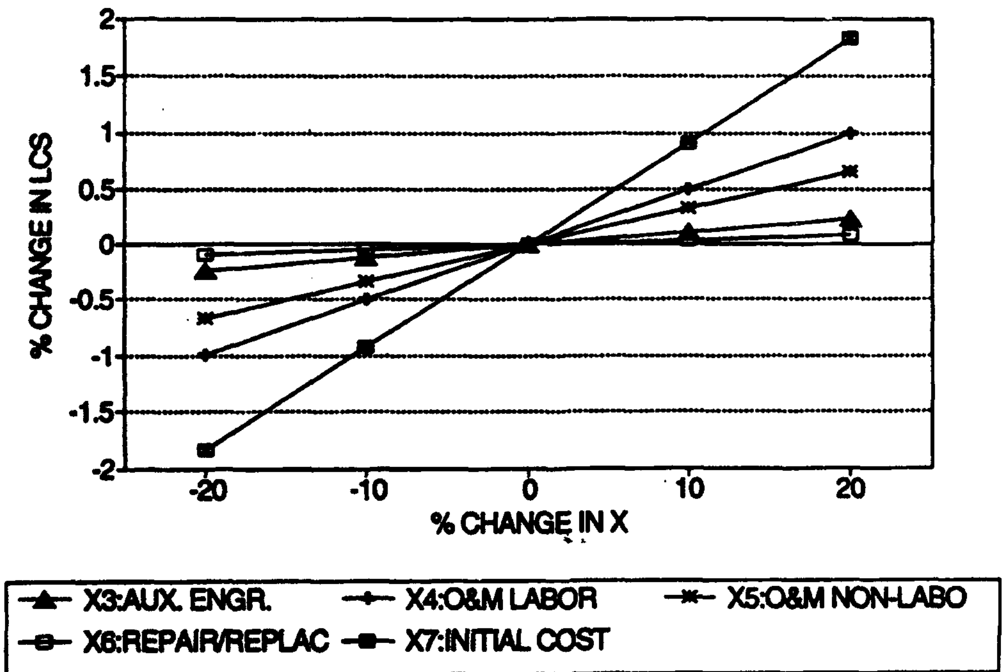

Figure 28. Effect of Auxiliary Energy, O&M Labor, O&M Non-Labor, Repair/Replacement and Initial Costs of the LCC of a #6 Oil-Fired Boiler Plant, Fort Bragg.

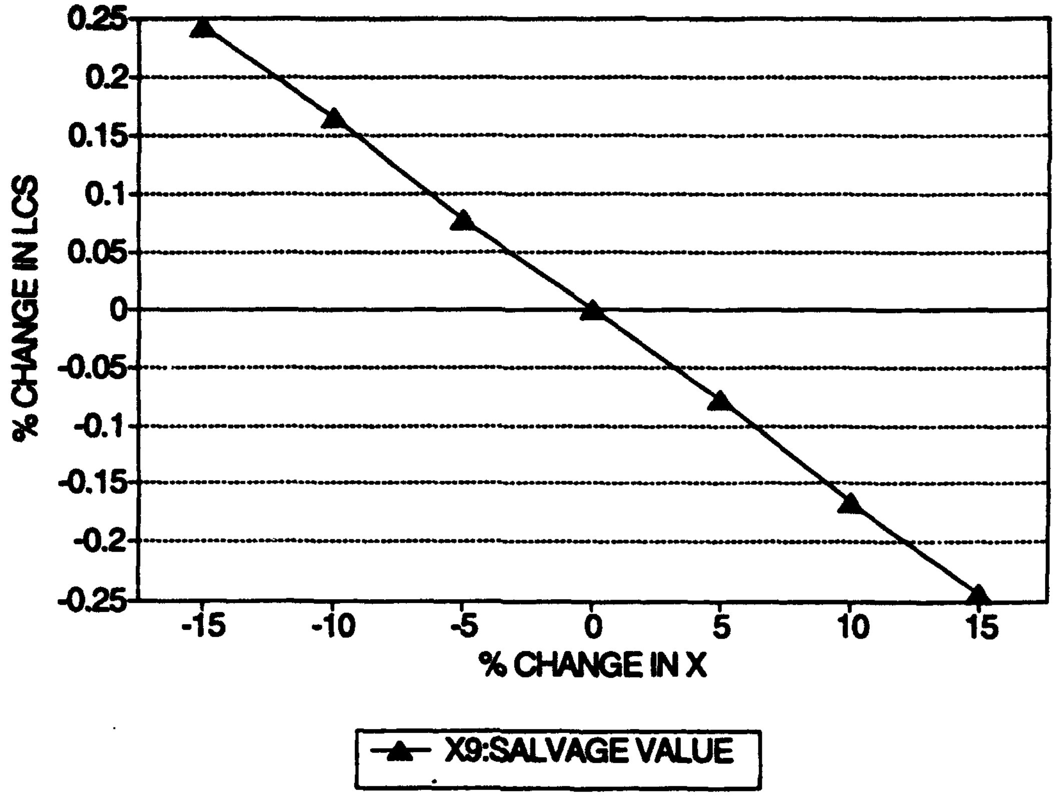

Figure 29. Effect of Salvage Value on the LCC of a #6 Oil-Fired Boiler Plant, Fort Bragg.

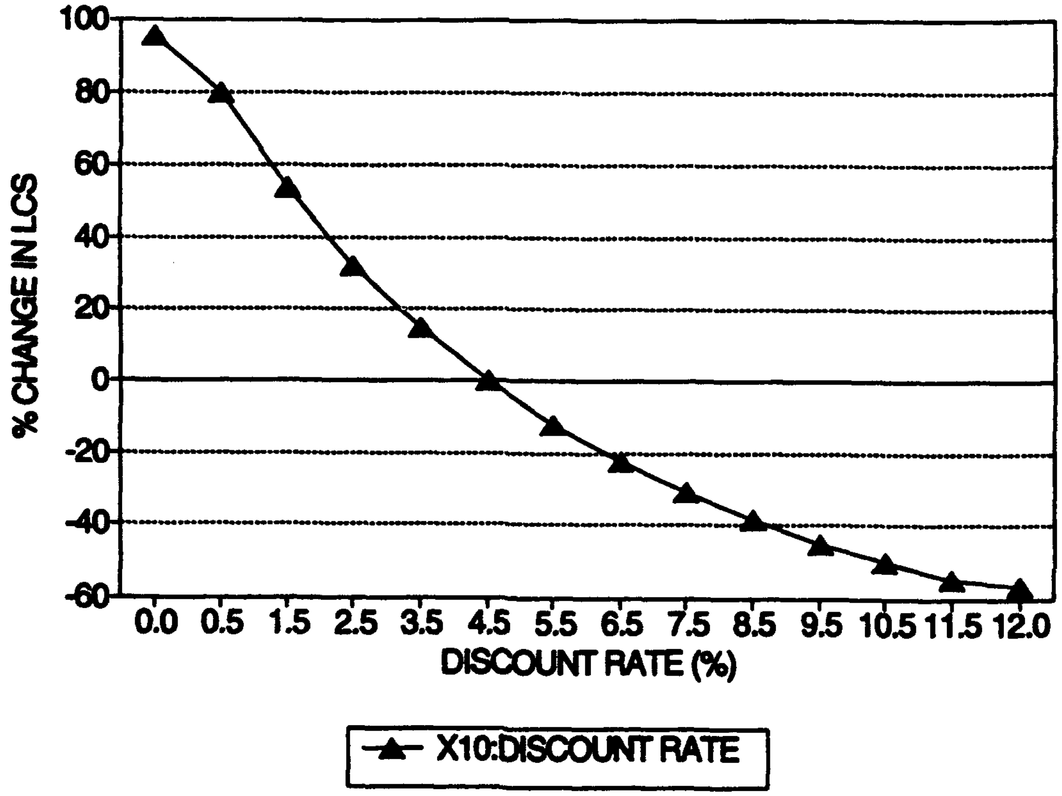

Figure 30. Effect of Discount Rate on the LCC of a #6 Oil-Fired Boiler Plant, Fort Bragg.

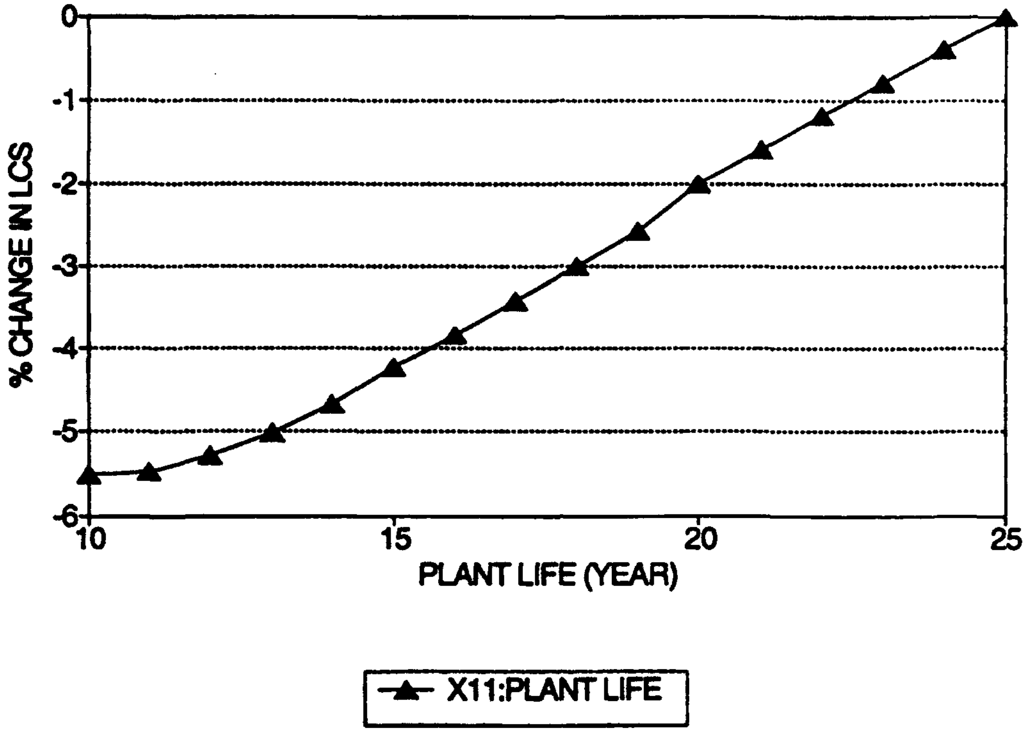

Figure 31. Effect of Plant Life on the LCC of a #6 Oil-Fired Boiler Plant, Fort Bragg.

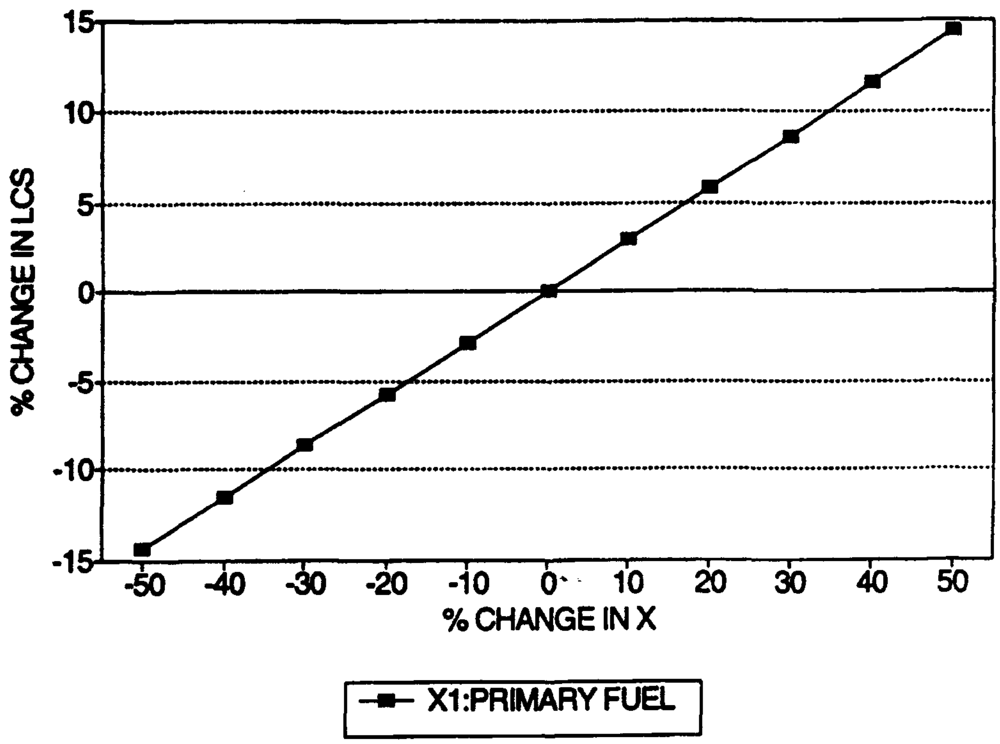

Figure 32. Effect of Primary Fuel Cost on the LCC of a Coal-Fired Stoker Plant, Fort Bragg.

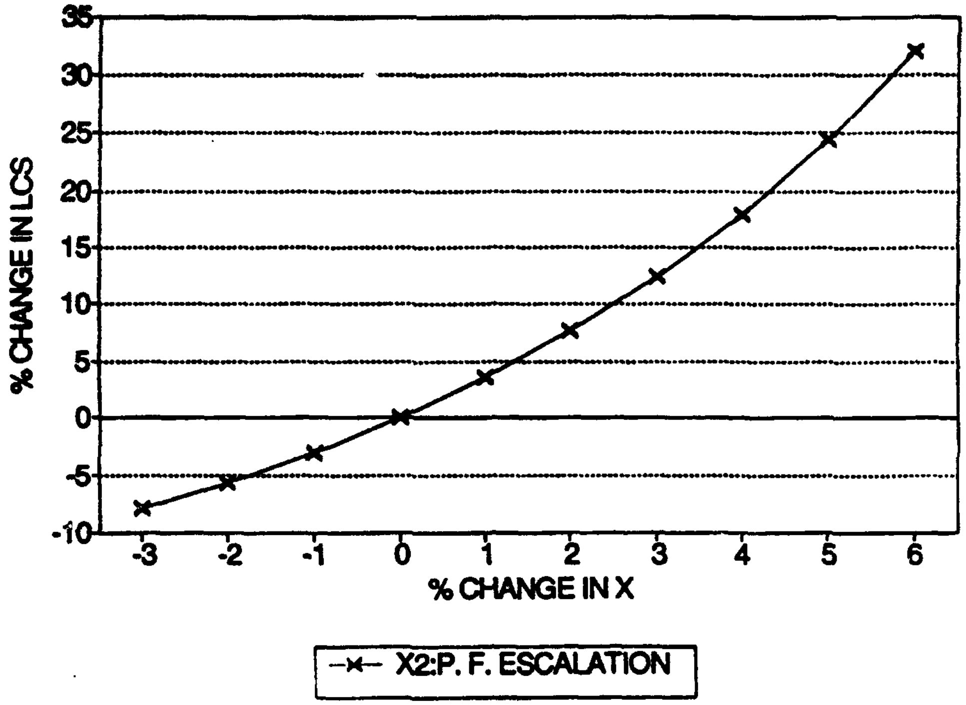

Figure 33. Effect of Primary Fuel Escalation on the LCC of a Coal-Fired Stoker Plant, Fort Bragg.

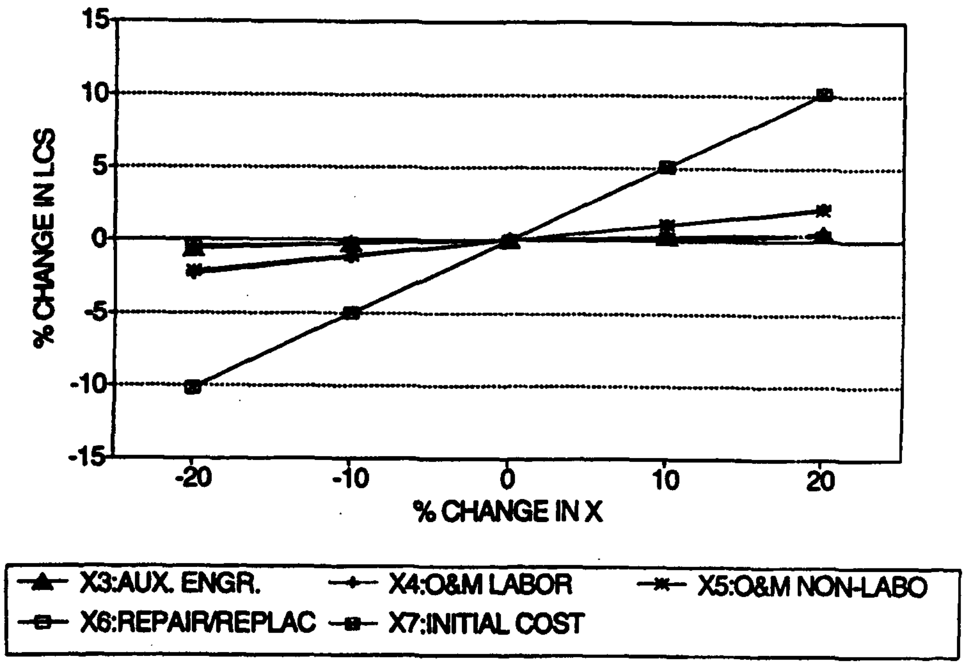

Figure 34. Effect of Auxiliary Energy, O&M Labor, O&M Non-labor, Repair/Replacement and Initial Costs on a Coal-Fired Stoker Plant, Fort Bragg.

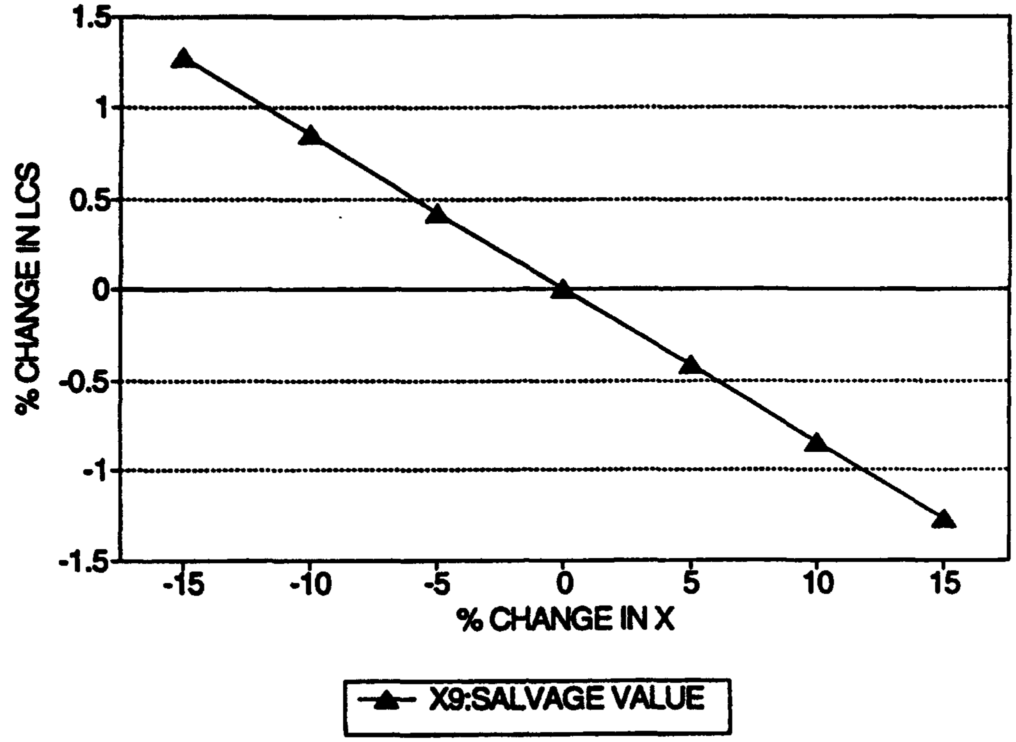

Figure 35. Effect of Salvage Value on the LCC of a Coal-Fired Stoker Plant, Fort Bragg.

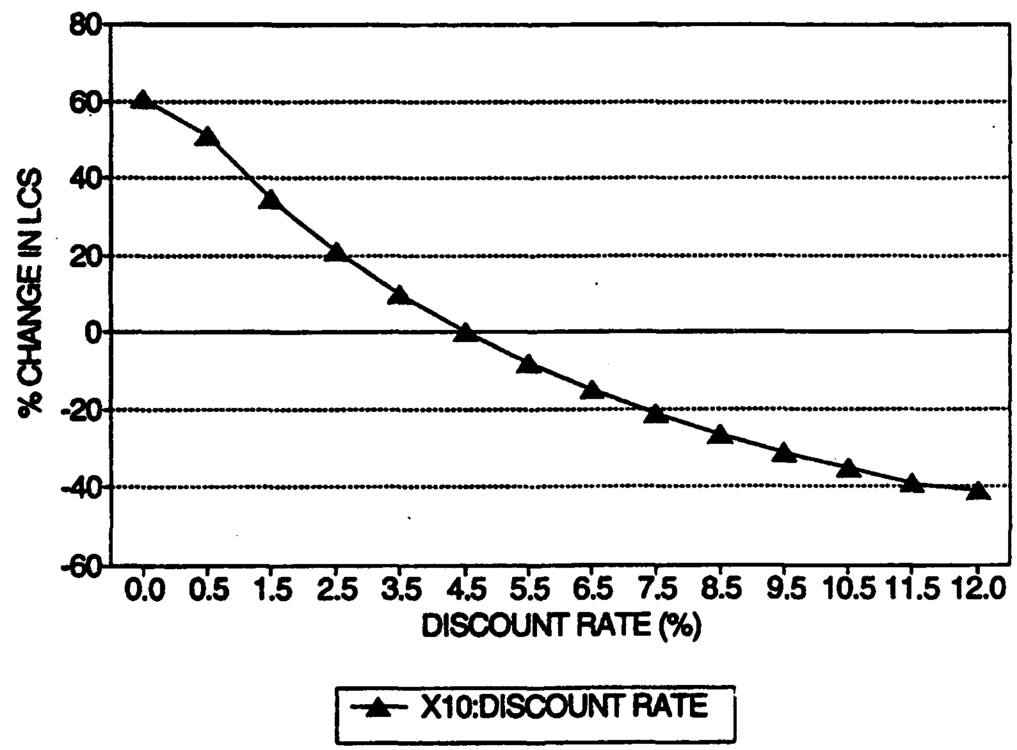

Figure 36. Effect of Discount Rate on the LCC of a Coal-Fired Stoker Plant, Fort Bragg.

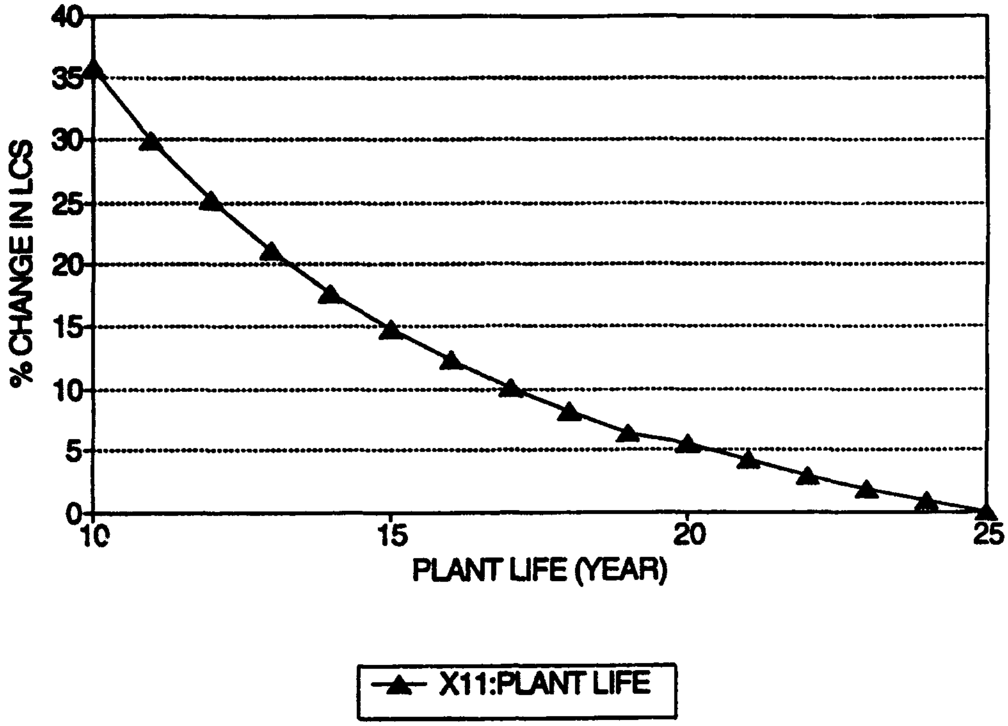

Figure 37. Effect of Plant Life on the LCC of a Coal-Fired Stoker Plant, Fort Bragg.

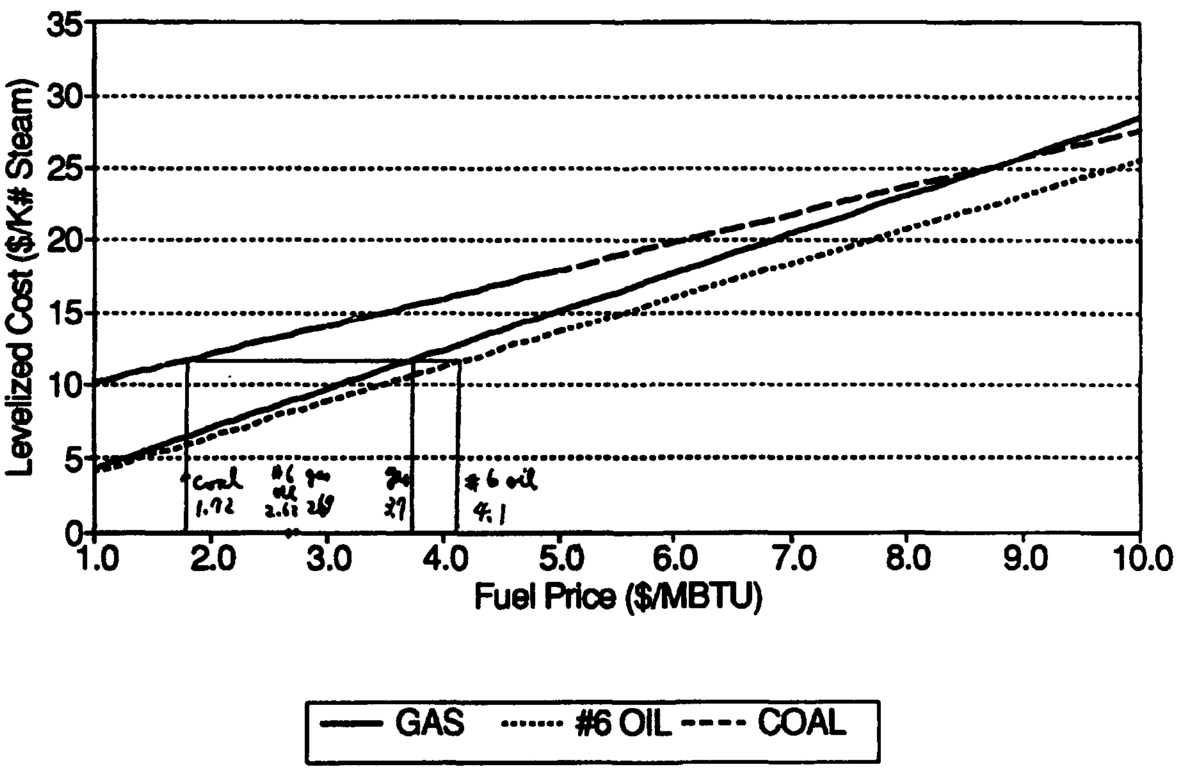

Figure 38. Leveled Cost of Service vs. Fuel Price; Fort Bragg.

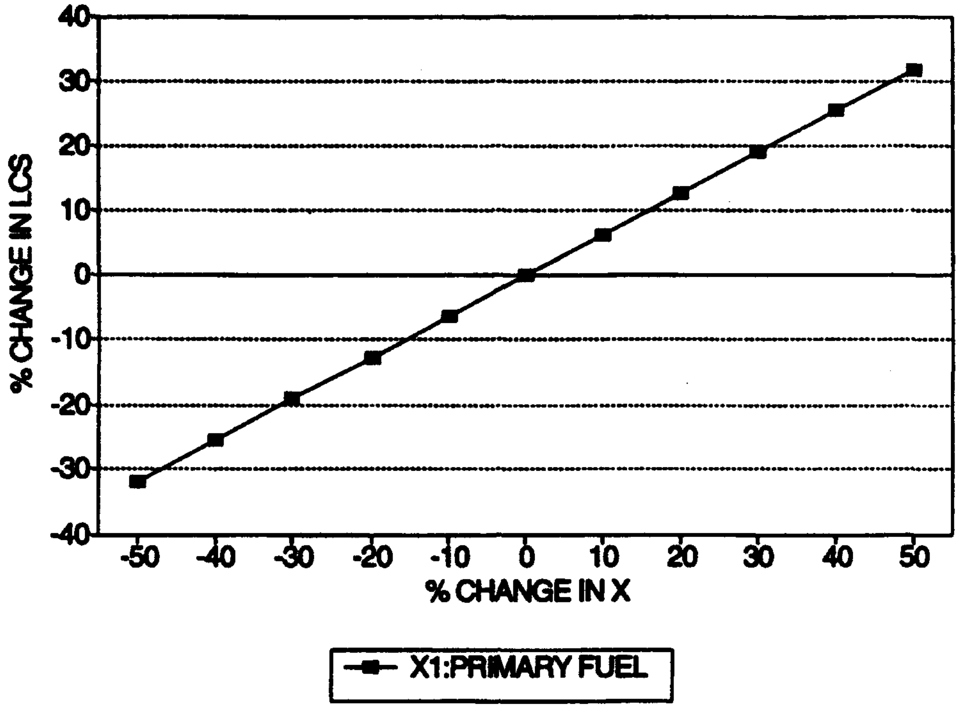

Figure 39. **Effect of Primary Fuel Cost on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Gordon.**

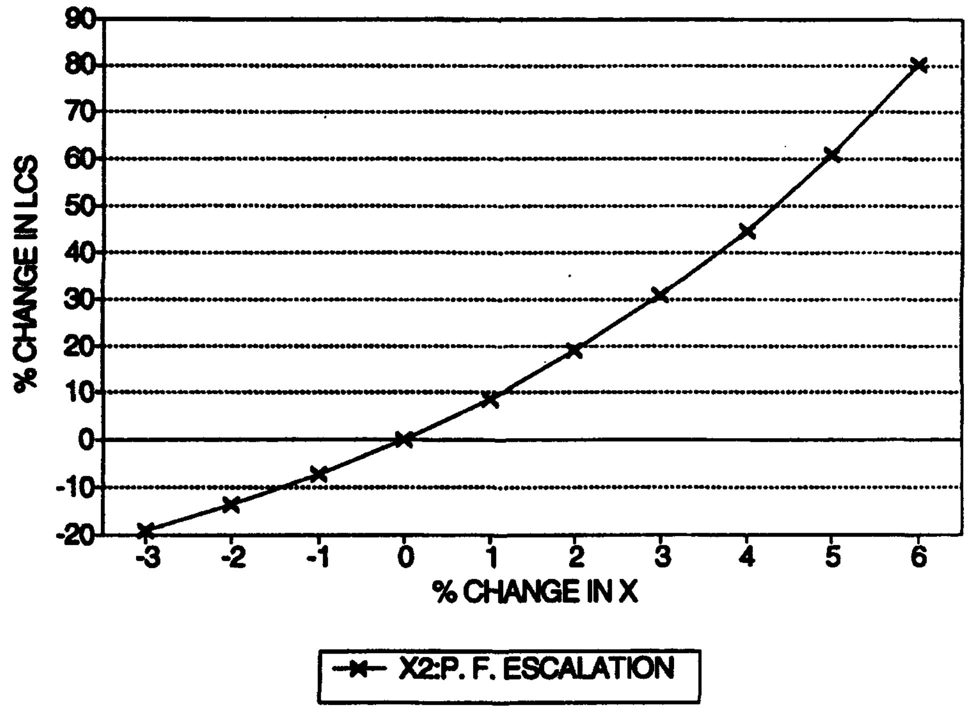

Figure 40. **Effect of Primary Fuel Escalation on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Gordon.**

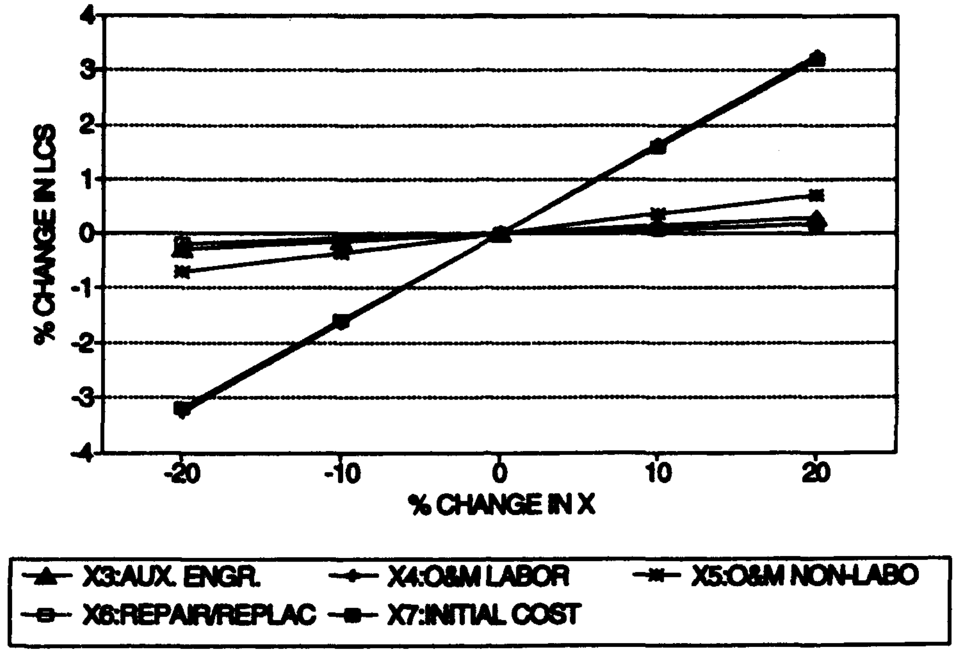

Figure 41. **Effect of Auxiliary Energy, O&M Labor, O&M Non-Labor, Repair/Replacement and Initial Costs on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Gordon.**

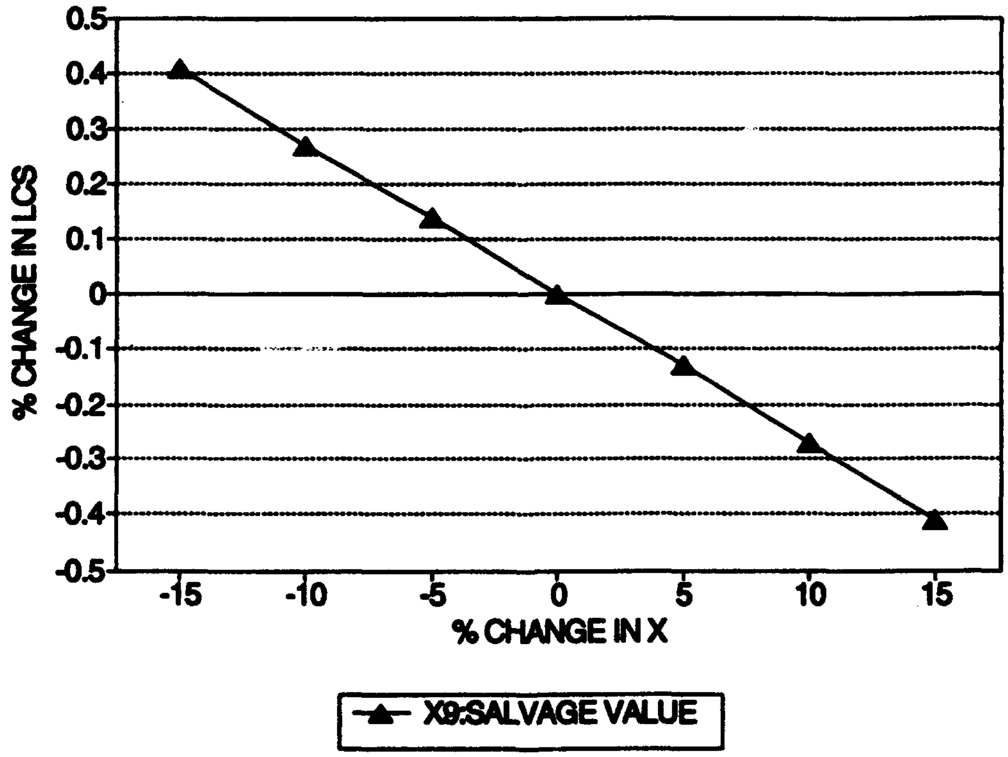

Figure 42. **Effect of Salvage Value on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Gordon.**

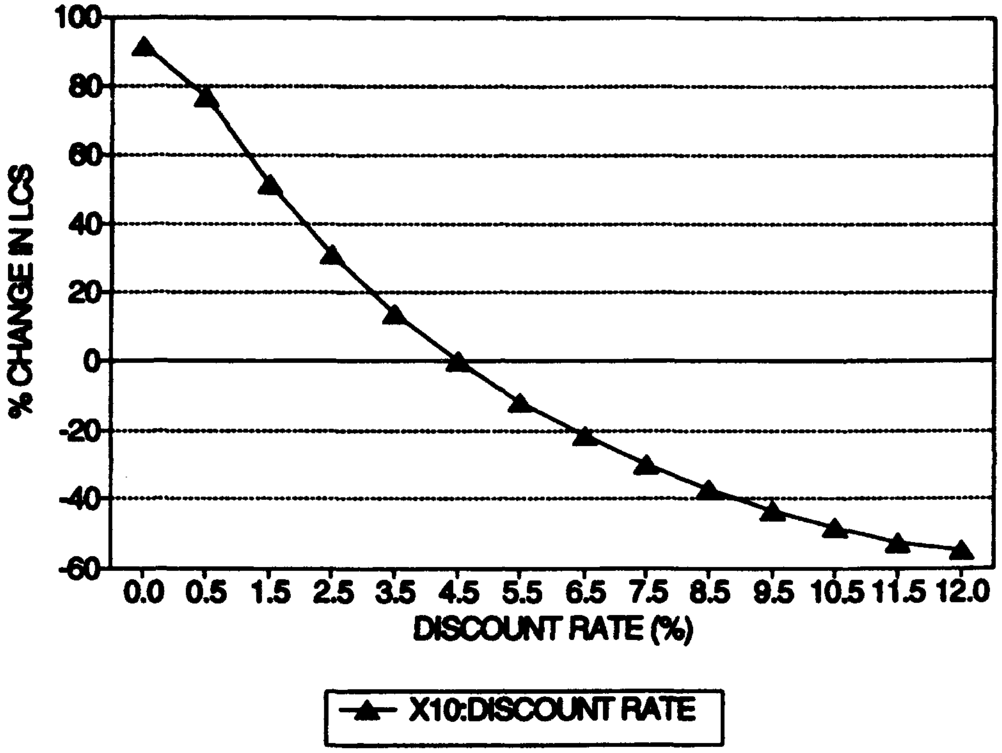

Figure 43. Effect of Discount Rate on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Gordon.

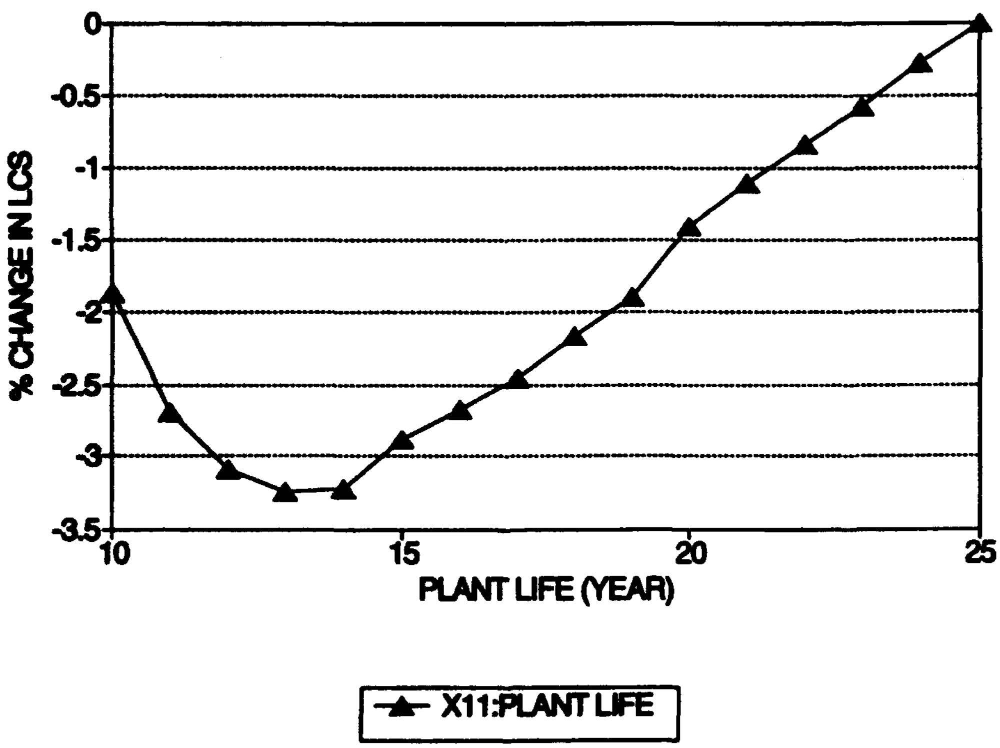

Figure 44. Effect of Plant Life on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Fort Gordon.

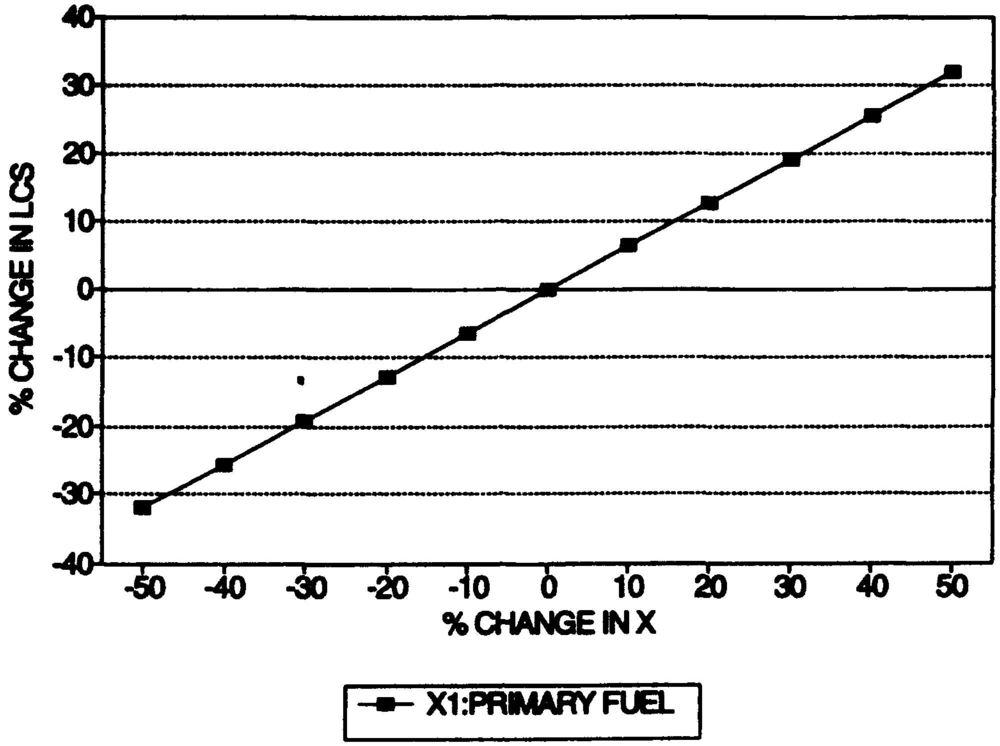

Figure 45. Effect of Primary Fuel Cost on the LCC of a #6 Oil-Fired Boiler Plant, Fort Gordon.

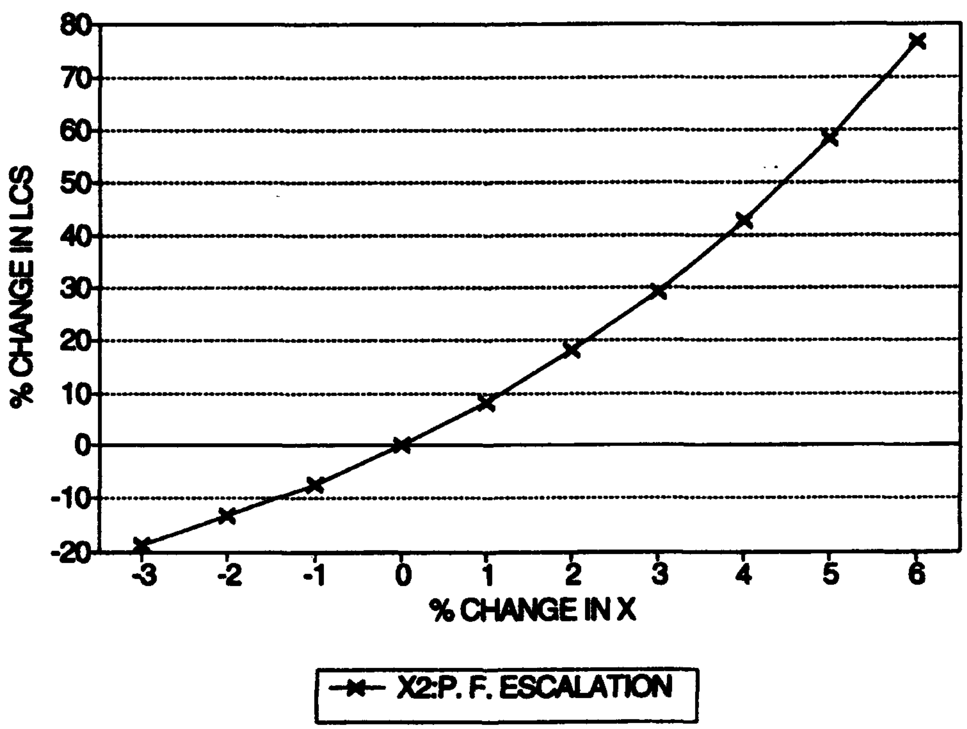

Figure 46. Effect of Primary Fuel Escalation on the LCC of a #6 Oil-Fired Boiler Plant, Fort Gordon.

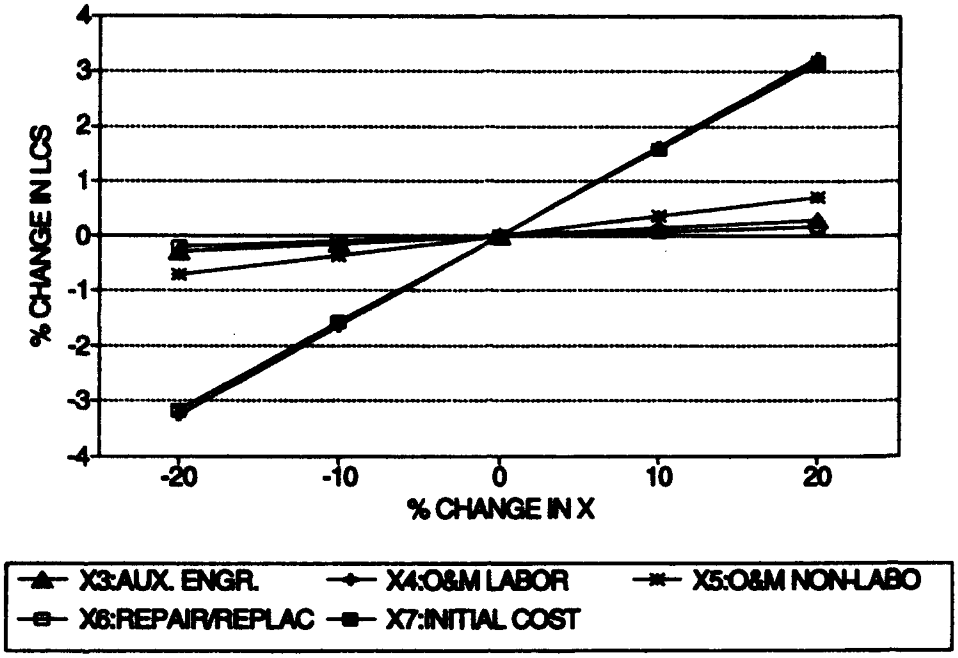

Figure 47. **Effect of Auxiliary Energy, O&M Labor, O&M Non-Labor, Repair/Replacement, Initial Costs on the LCC of a #6 Oil-Fired Boiler Plant, Fort Gordon .**

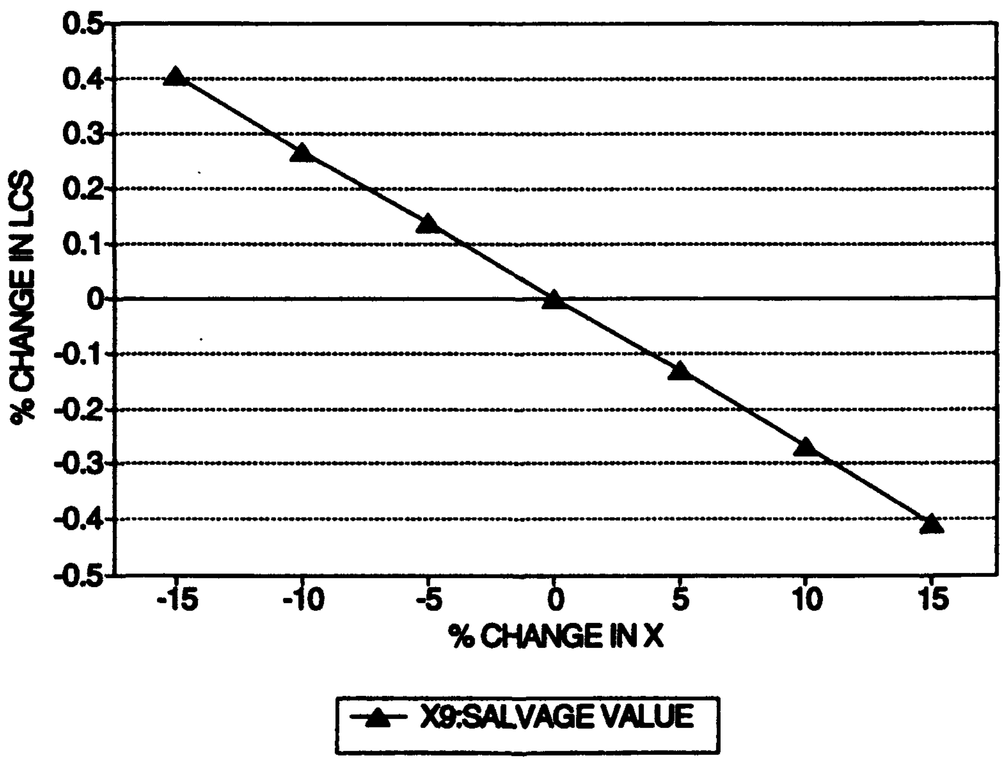

Figure 48. **Effect of Salvage Value on the LCC on a #6 Oil-Fired Boiler Plant, Fort Gordon.**

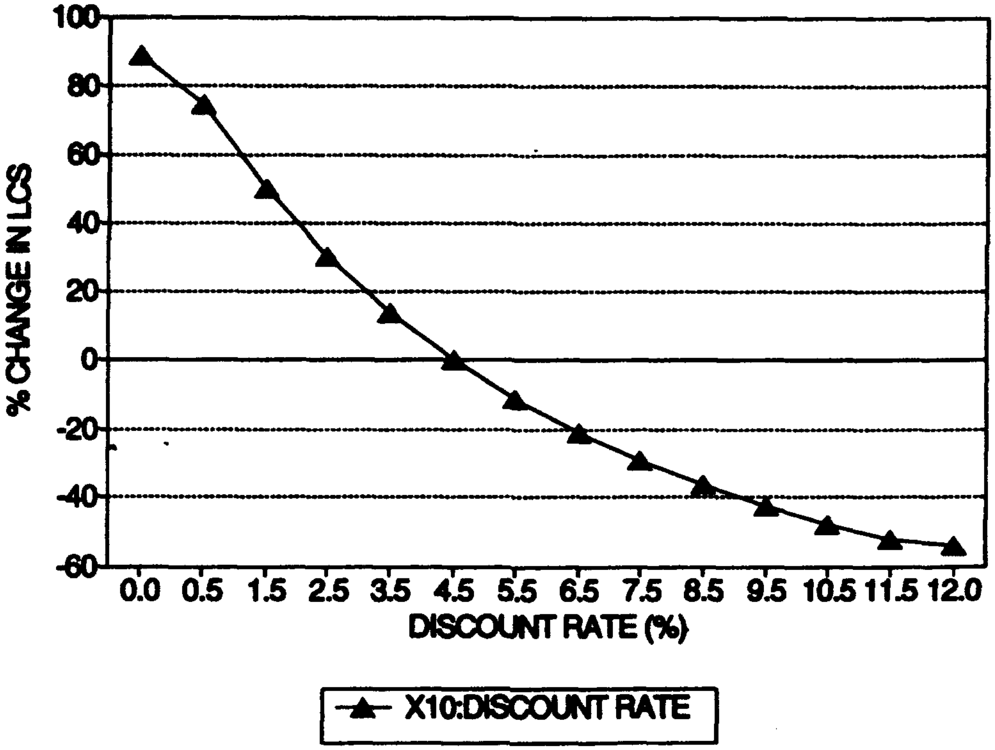

Figure 49. Effect of Discount Rate on the LCC of a #6 Oil-Fired Boiler Plant, Fort Gordon.

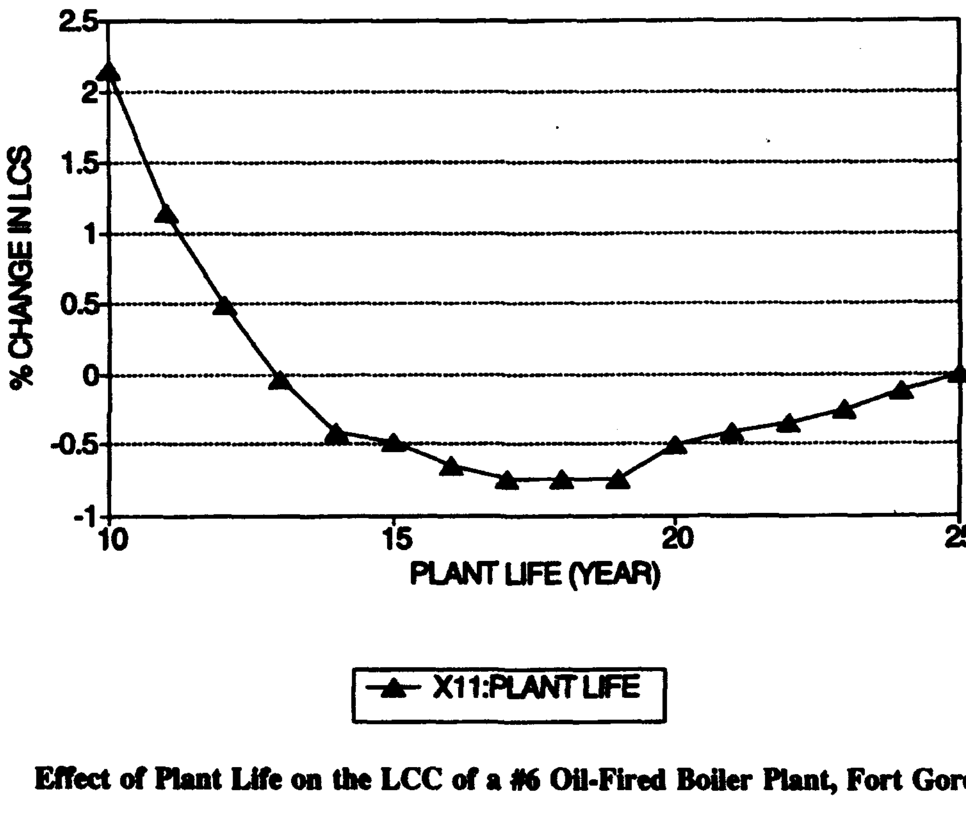

Figure 50. Effect of Plant Life on the LCC of a #6 Oil-Fired Boiler Plant, Fort Gordon.

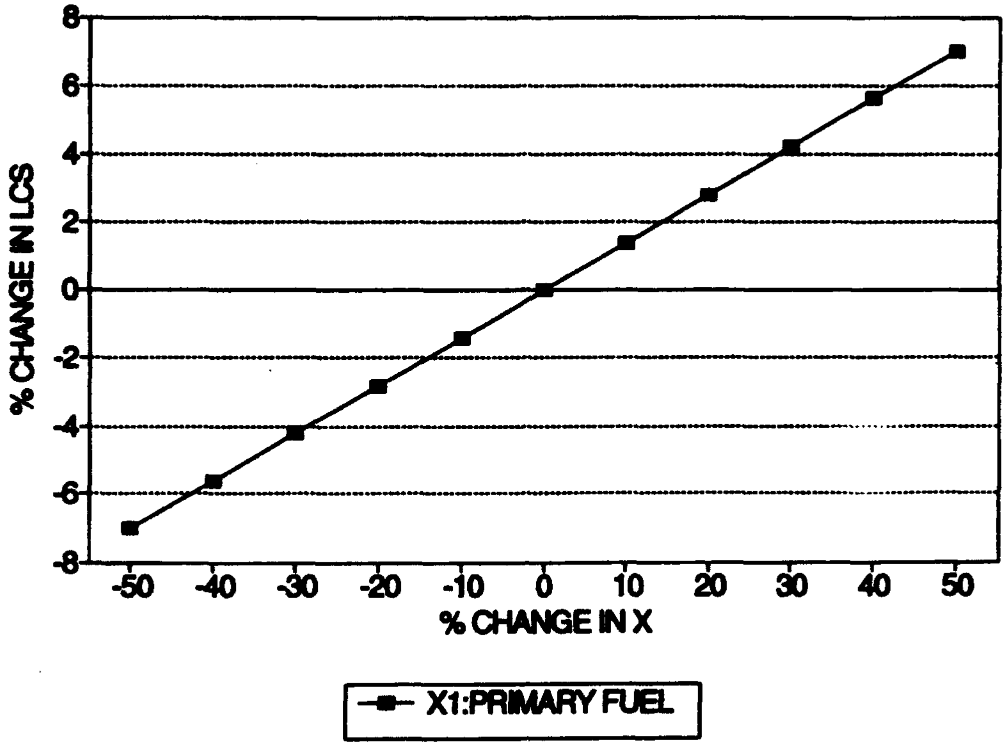

Figure 51. Effect of Primary Fuel Cost on the LCC of a Coal-Fired Stoker Plant, Fort Gordon.

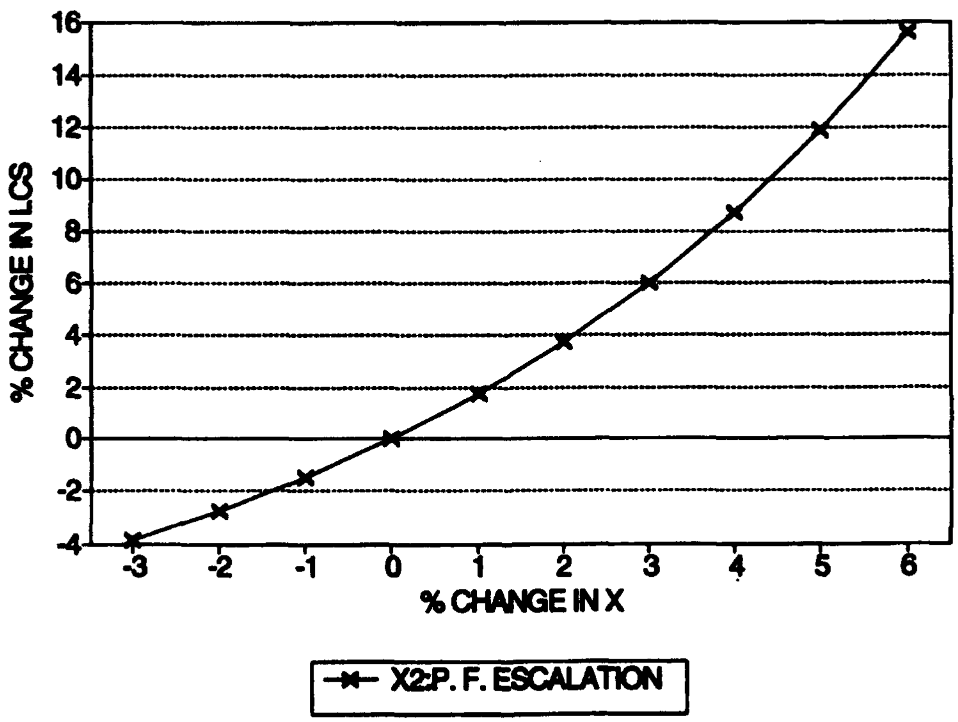

Figure 52. Effect of Primary Fuel Escalation on the LCC of a Coal-Fired Stoker Plant, Fort Gordon.

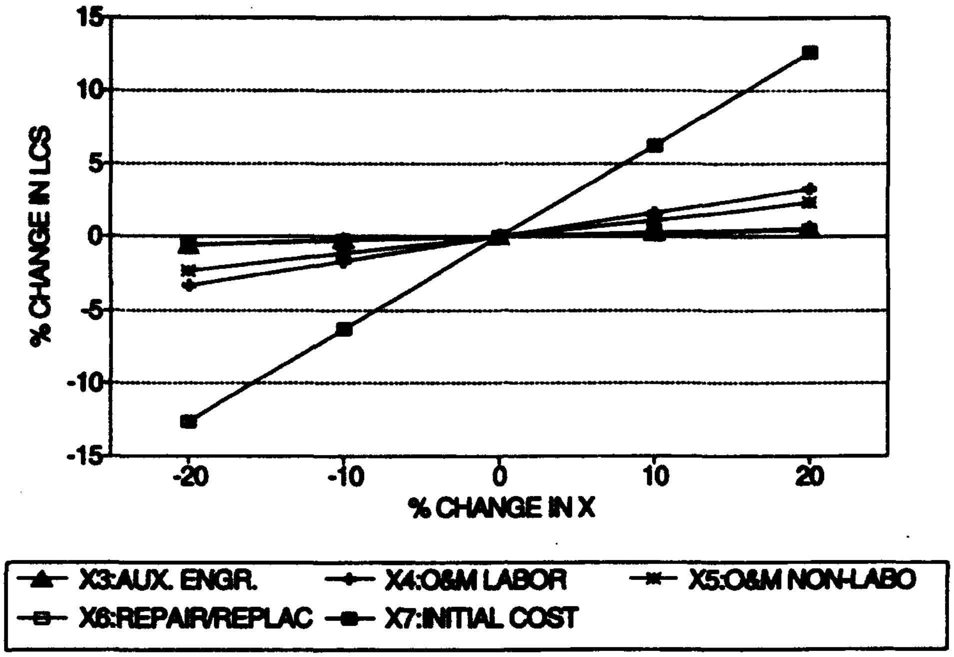

Figure 53. **Effect of Auxiliary Energy, O&M Labor, O&M Non-Labor, Repair/Replacement and Initial Costs on the LCC of a Coal-Fired Stoker Plant, Fort Gordon.**

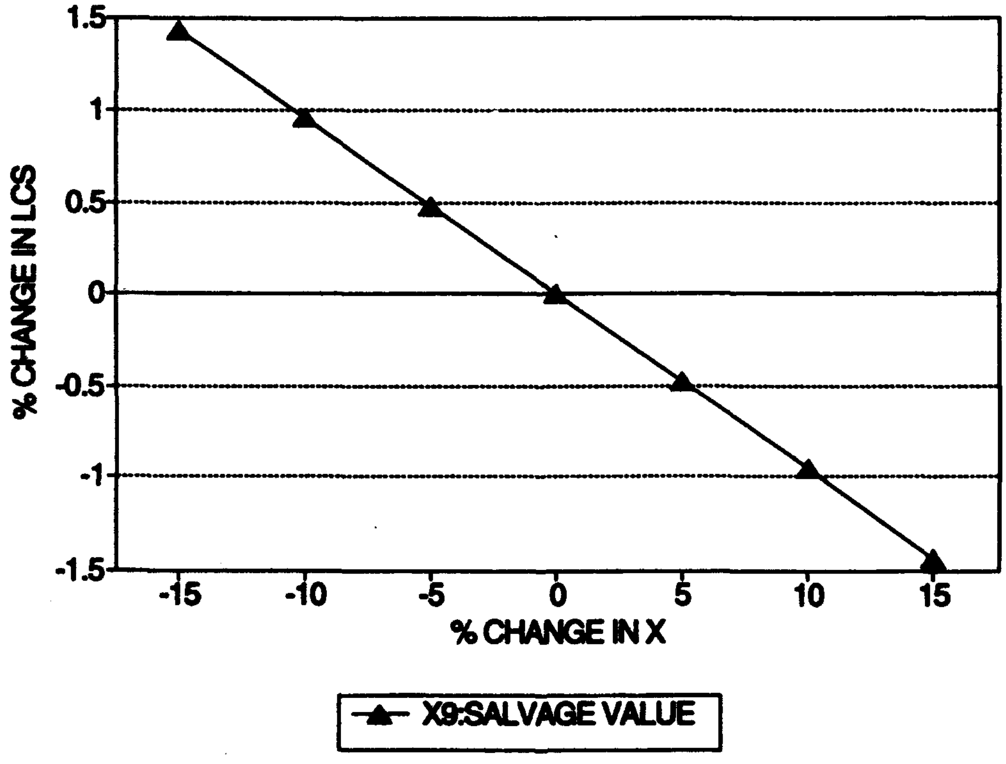

Figure 54. **Effect of Salvage Value on the LCC of a Coal-Fired Stoker Plant, Fort Gordon.**

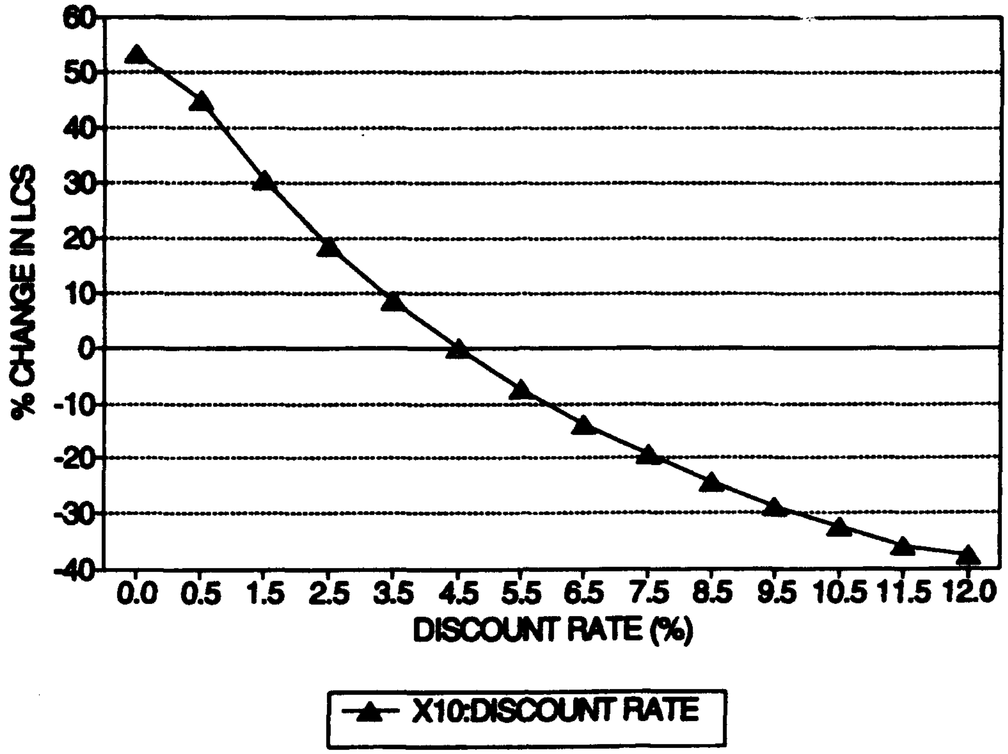

Figure 55. Effect of Discount Rate on the LCC of a Coal-Fired Stoker Plant, Fort Gordon.

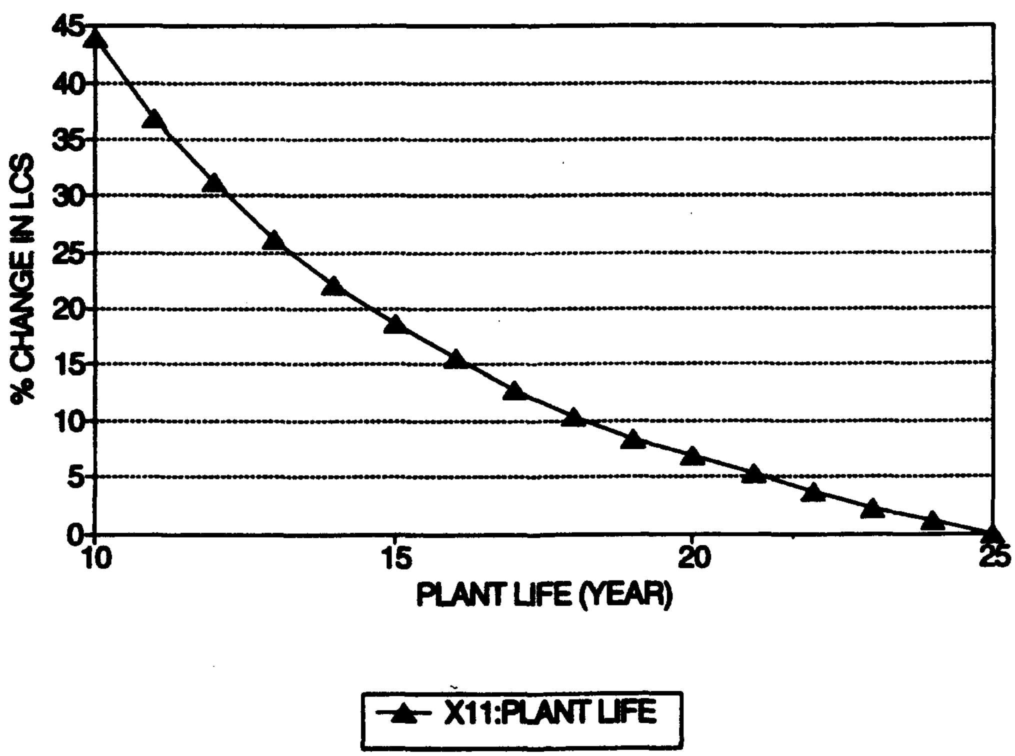

Figure 56. Effect of Plant Life on the LCC of a Coal-Fired Stoker Plant, Fort Gordon.

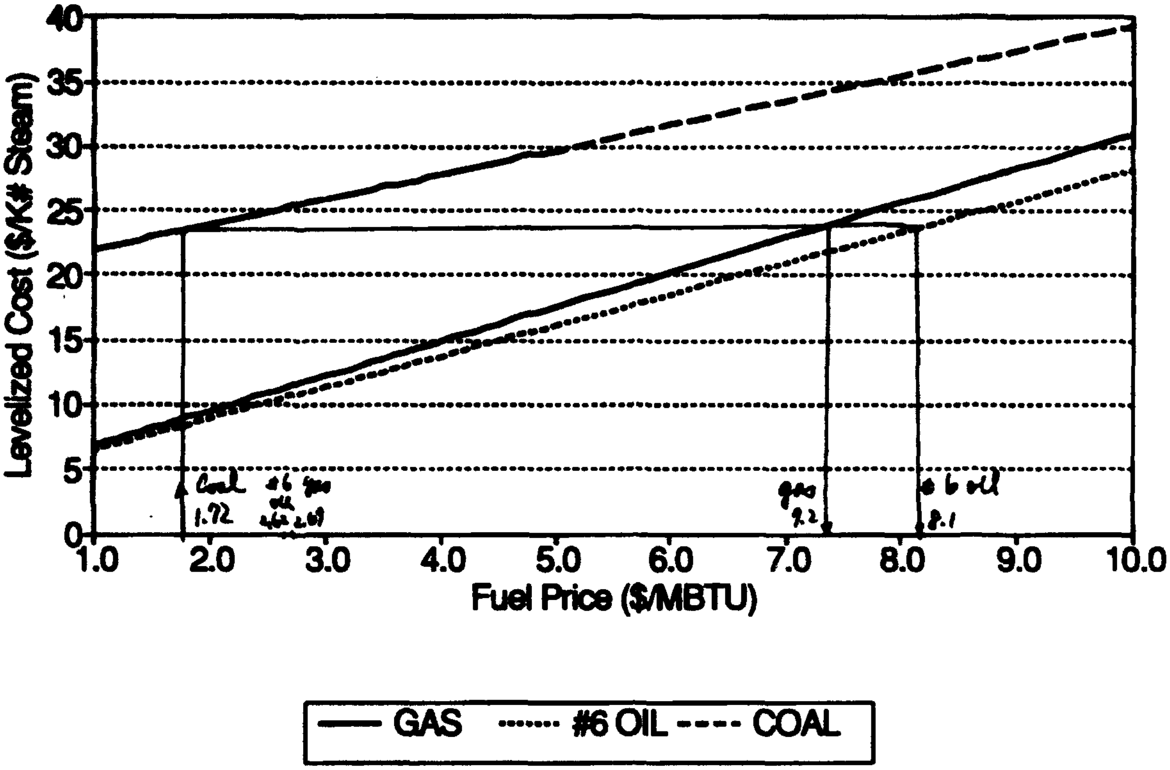

Figure 57. **Leveled Cost of Service vs. Fuel Price; Fort Gordon.**

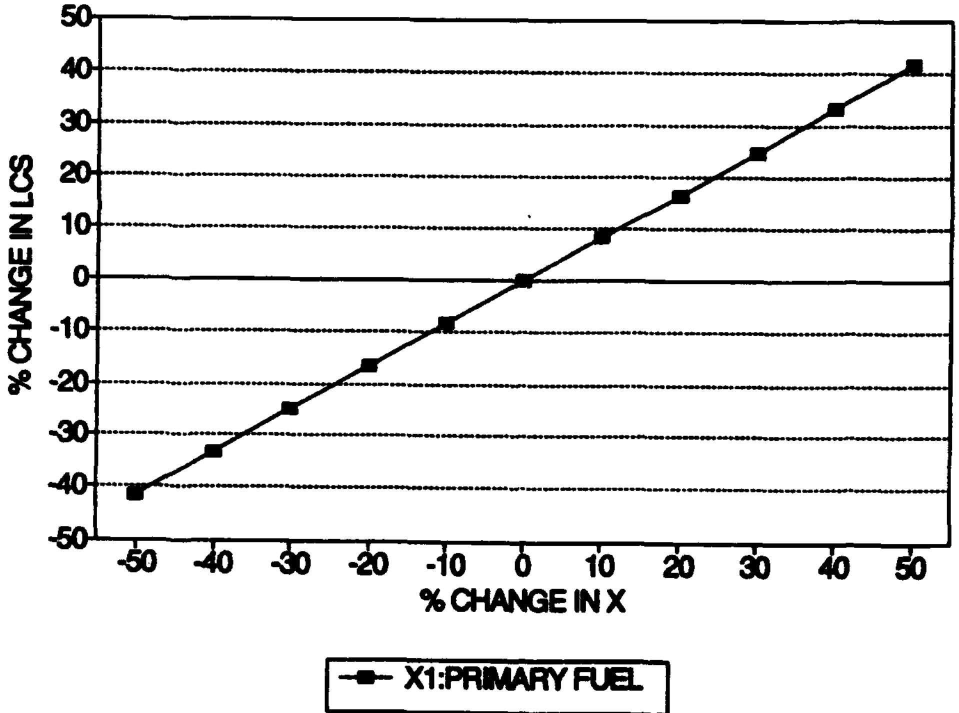

Figure 58. **Effect of Primary Fuel Cost on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Picatinny Arsenal.**

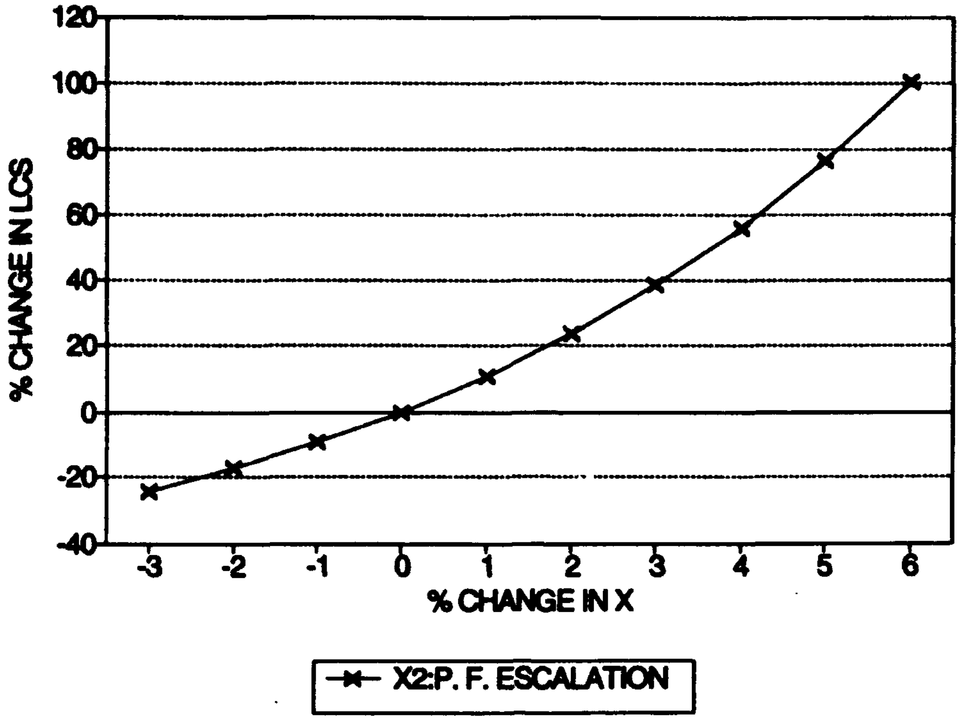

Figure 59. Effect of Primary Fuel Escalation on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Picatinny Arsenal.

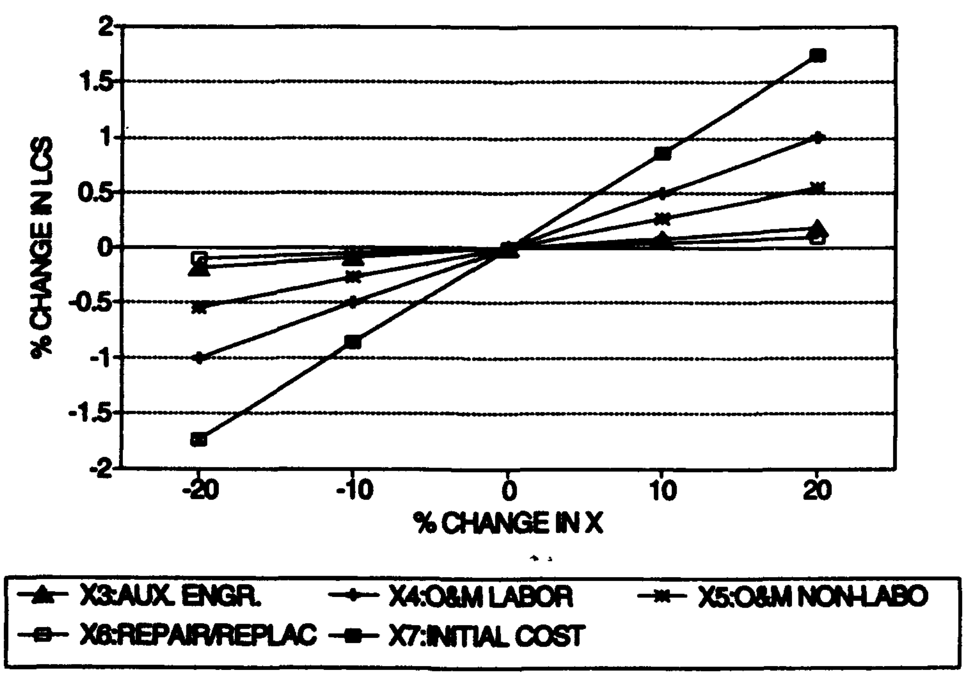

Figure 60. Effect of Auxiliary Energy, O&M Labor, O&M Non-Labor, Repair/Replacement and Initial Costs on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Picatinny Arsenal.

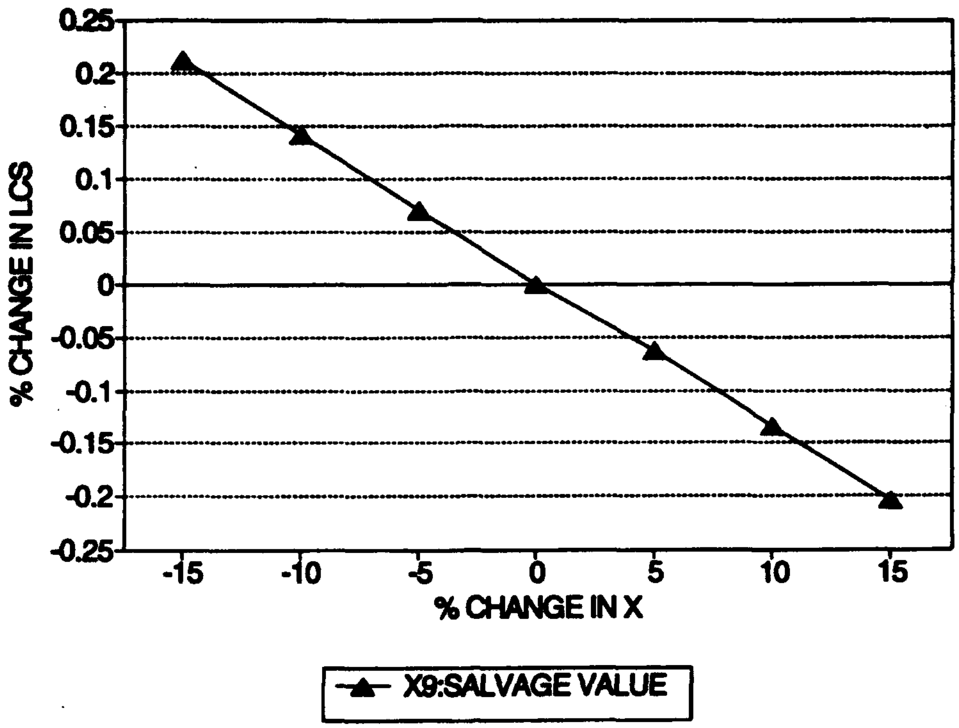

Figure 61. Effect of Salvage Value on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Picatinny Arsenal.

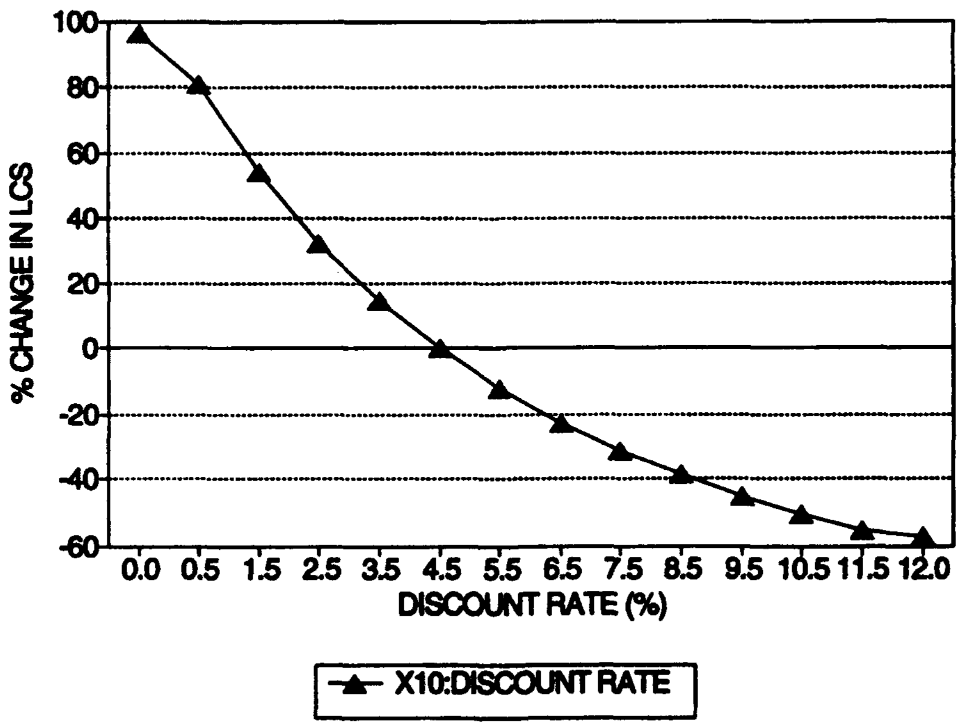

Figure 62. Effect of Discount Rate on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Picatinny Arsenal.

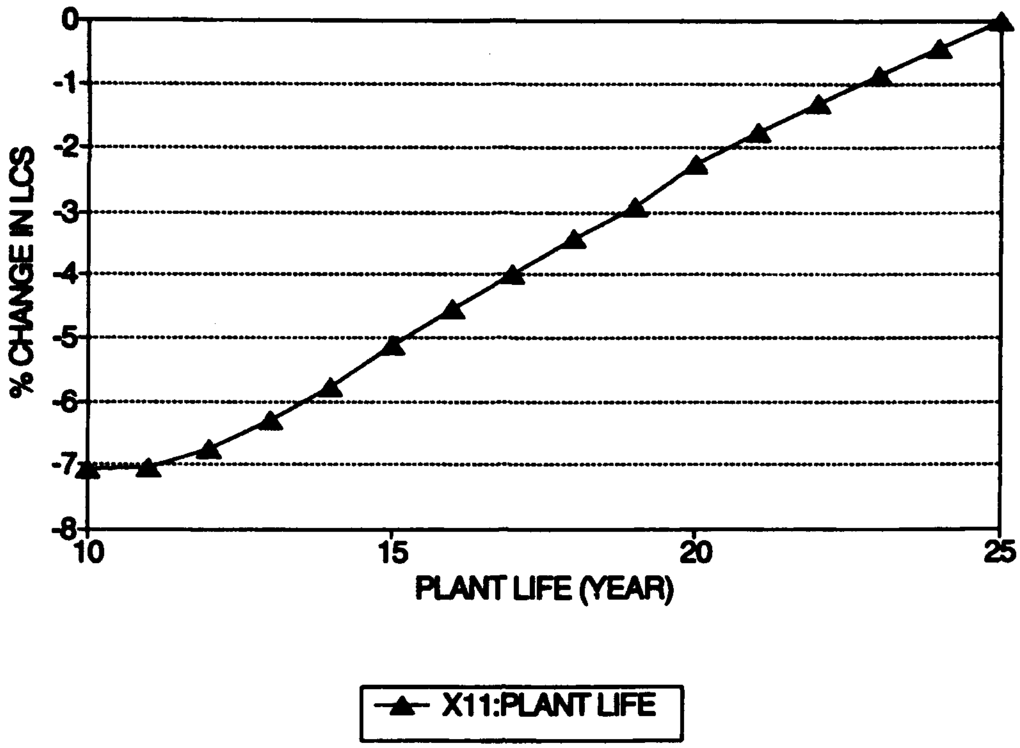

Figure 63. **Effect of Plant Life on the LCC of a Gas/#2 Oil-Fired Boiler Plant, Picatinny Arsenal.**

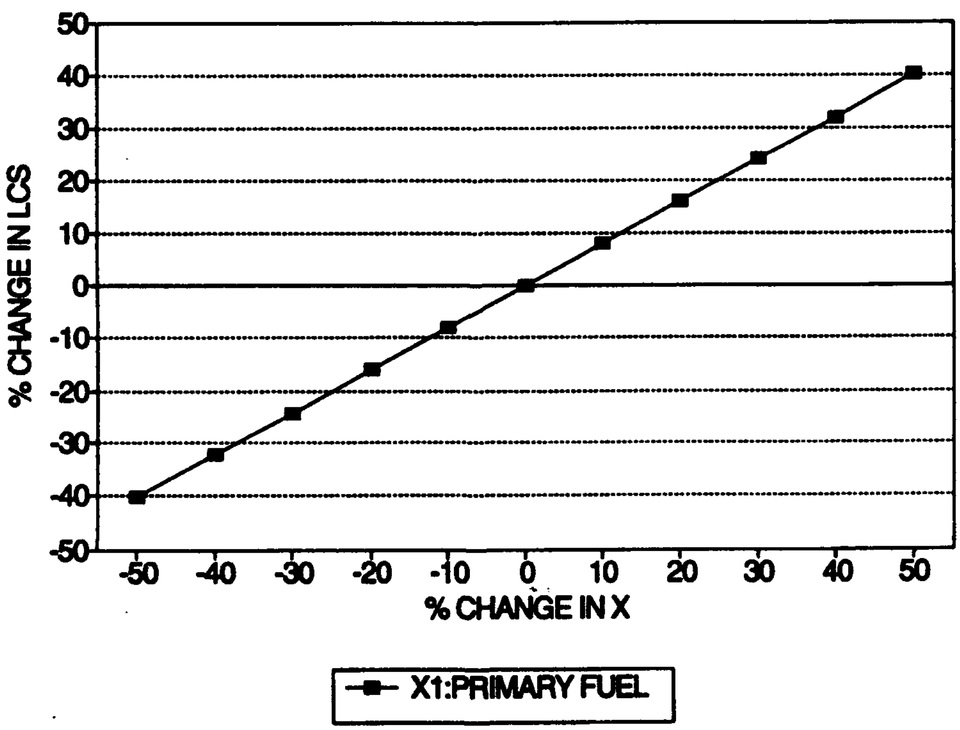

Figure 64. **Effect of Primary Fuel Cost on the LCC of a #6 Oil-Fired Boiler Plant, Picatinny Arsenal.**

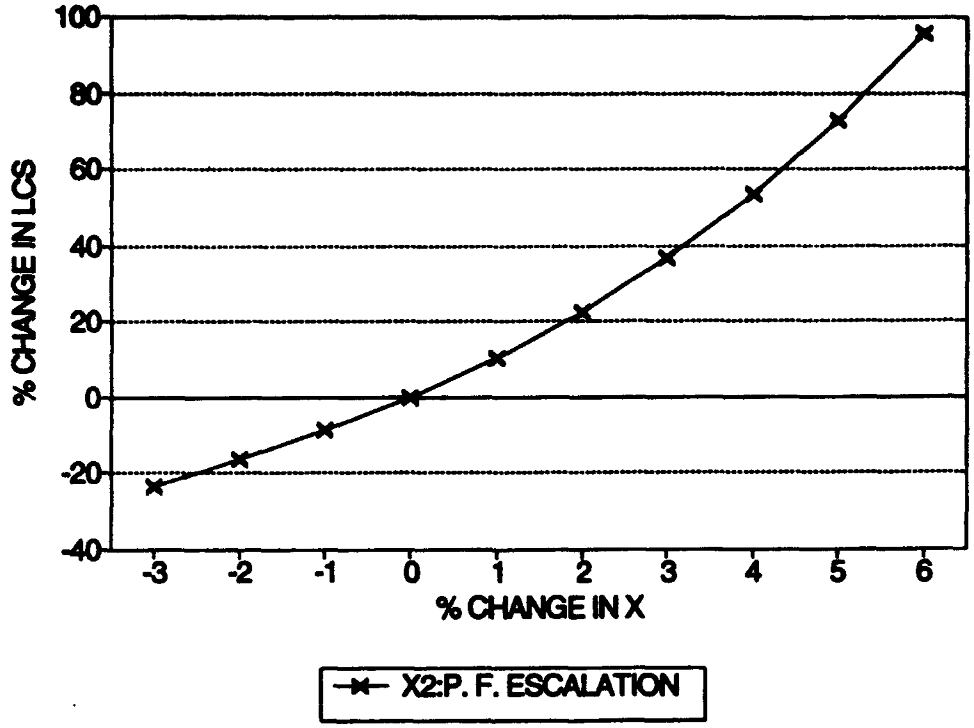

Figure 65. **Effect of Primary Fuel Escalation Cost on the LCC of an #6 Oil-Fired Boiler Plant, Picatinny Arsenal.**

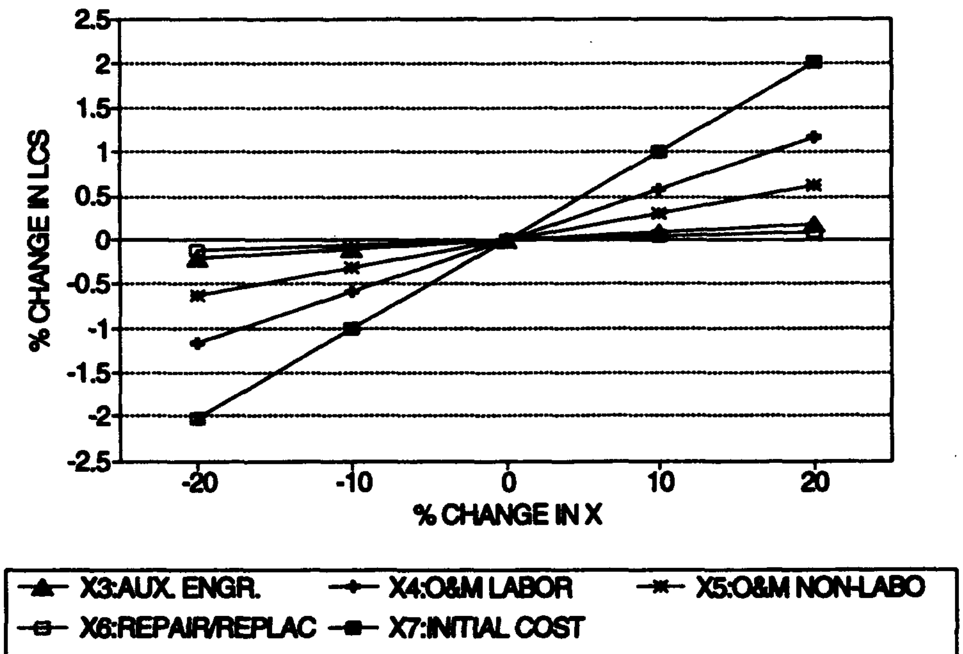

Figure 66. **Effect of Auxiliary Energy, O&M Labor, O&M Non-Labor, Repair/Replacement and Initial Costs of a #6 Oil-Fired Boiler Plant, Picatinny Arsenal.**

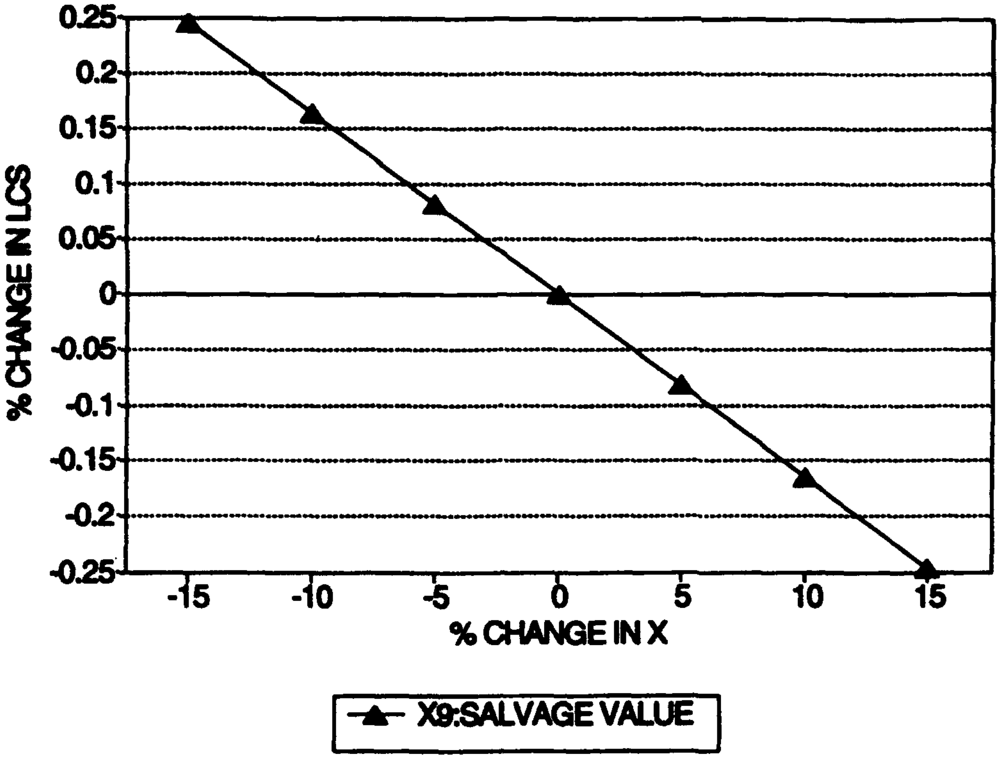

Figure 67. Effect of Salvage Value on the LCC of a #6 Oil-Fired Boiler Plant, Picatinny Arsenal.

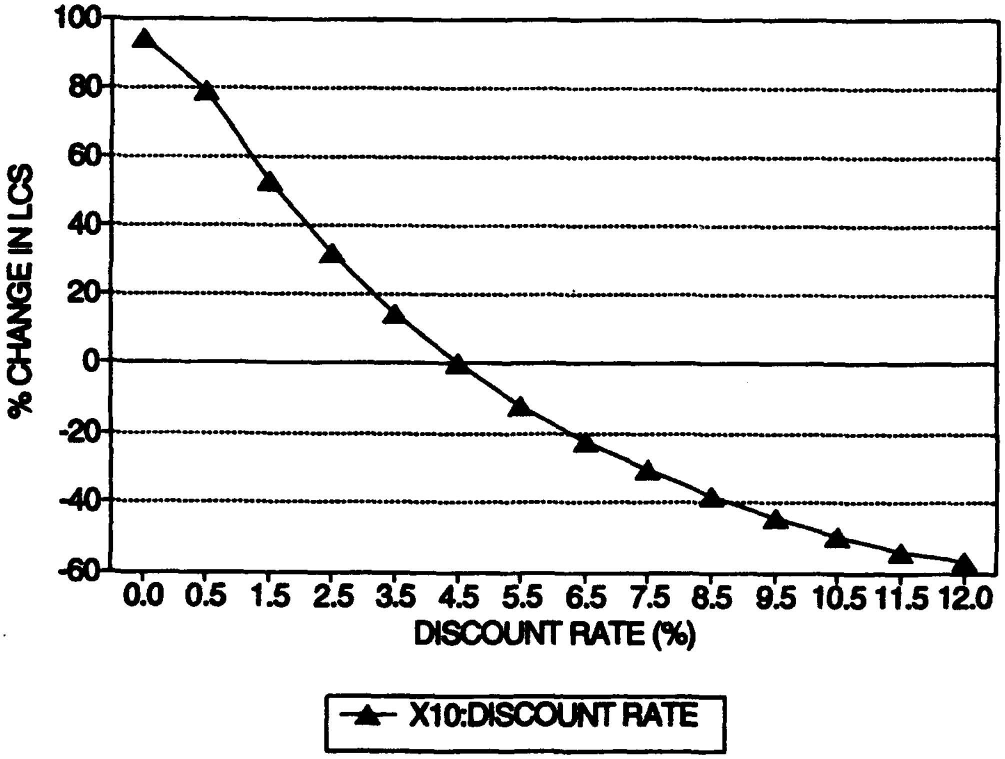

Figure 68. Effect of Discount Rate on the LCC of a #6 Oil-Fired Boiler Plant, Picatinny Arsenal.

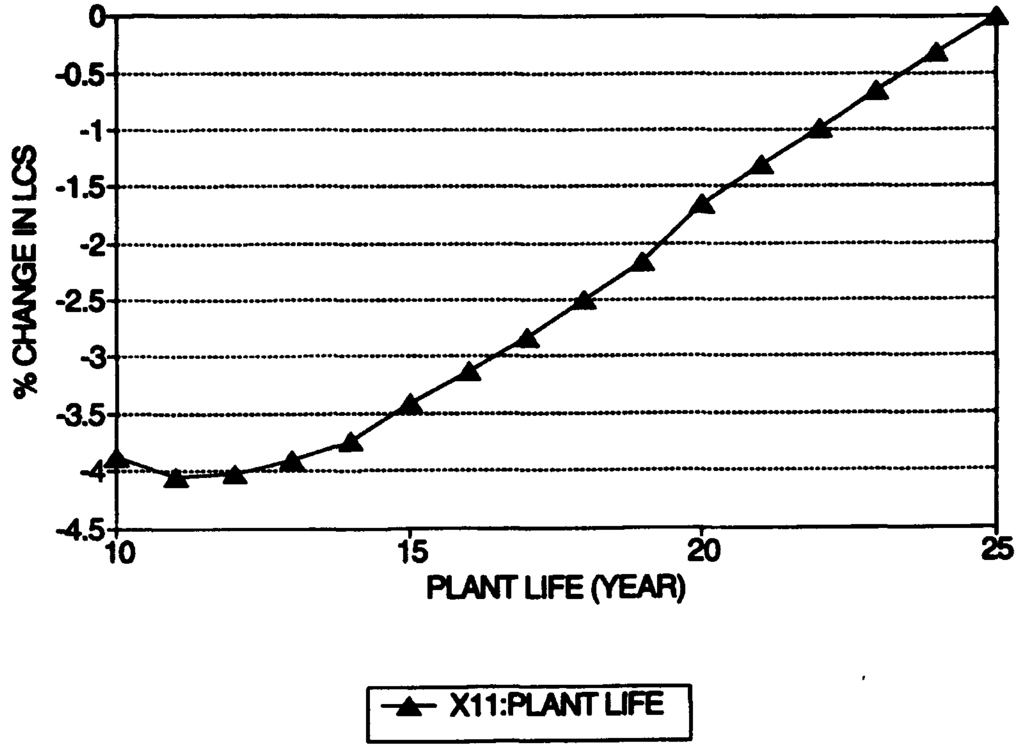

Figure 69. Effect of Plant Life on the LCC of a #6 Oil-Fired Boiler Plant, Picatinny Arsenal.

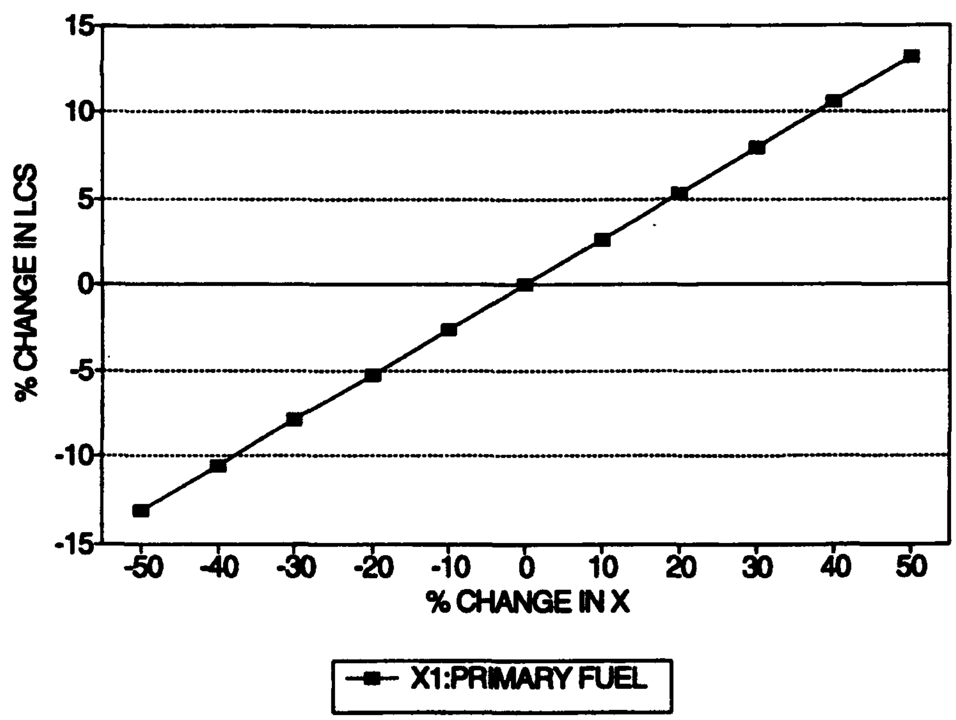

Figure 70. Effect of Primary Fuel Cost on the LCC of a Coal-Fired Stoker Plant, Picatinny Arsenal.

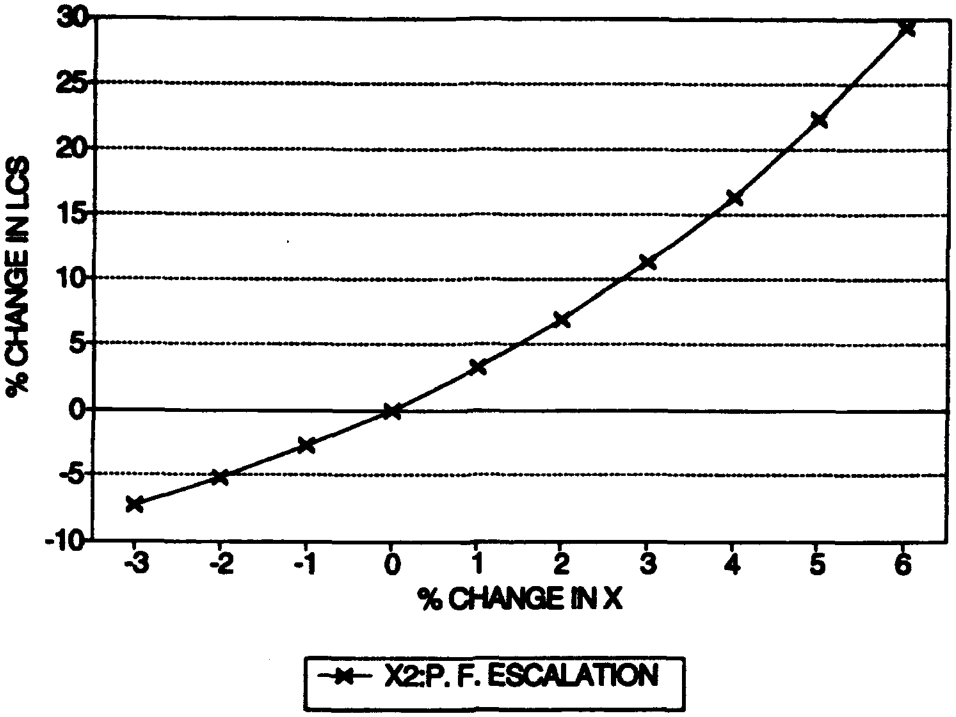

Figure 71. Effect of Primary Fuel Cost Escalation on the LCC of a Coal-Fired Stoker Plant, Picatinny Arsenal.

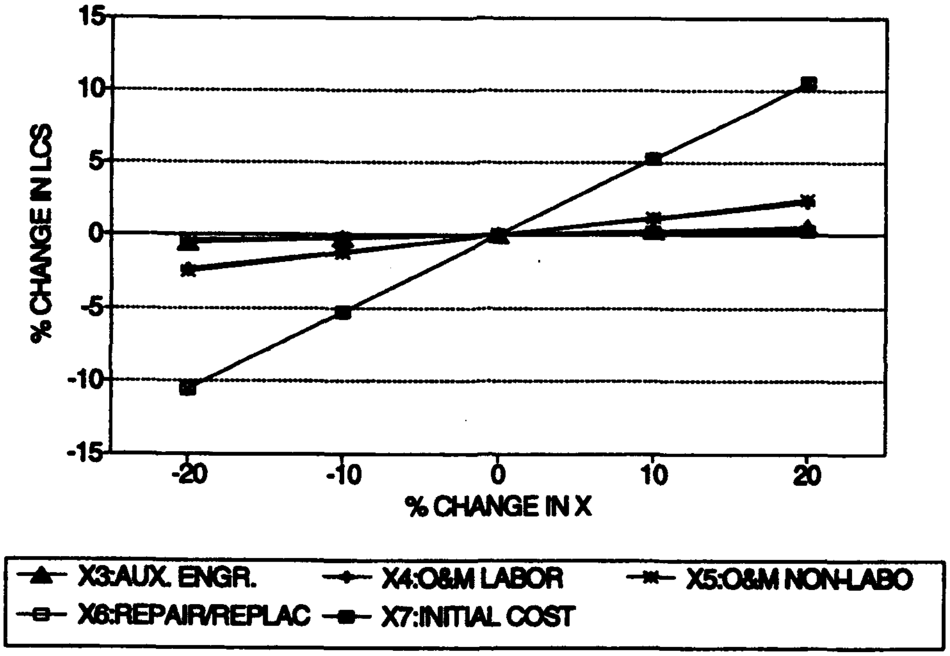

Figure 72. Effect of Auxiliary Energy, O&M Labor, O&M Labor, Repair/Replacement and Initial Costs of a Coal-Fired Stoker Plant, Picatinny Arsenal.

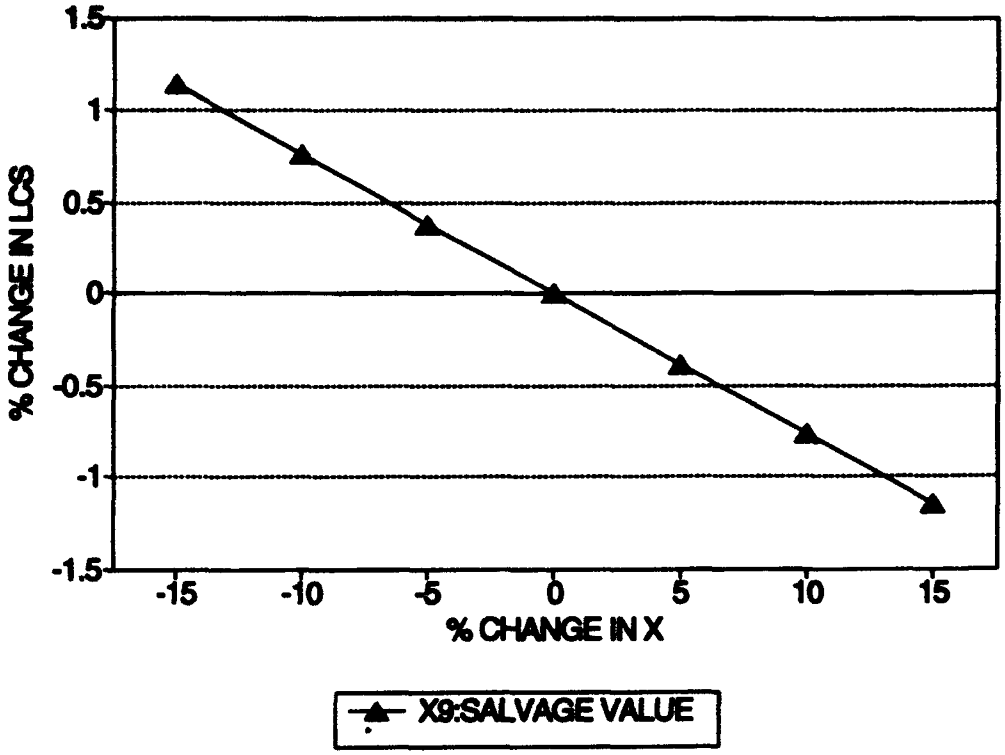

Figure 73. Effect of Salvage Value on the LCC of a Coal-Fired Stoker Plant, Picatinny Arsenal.

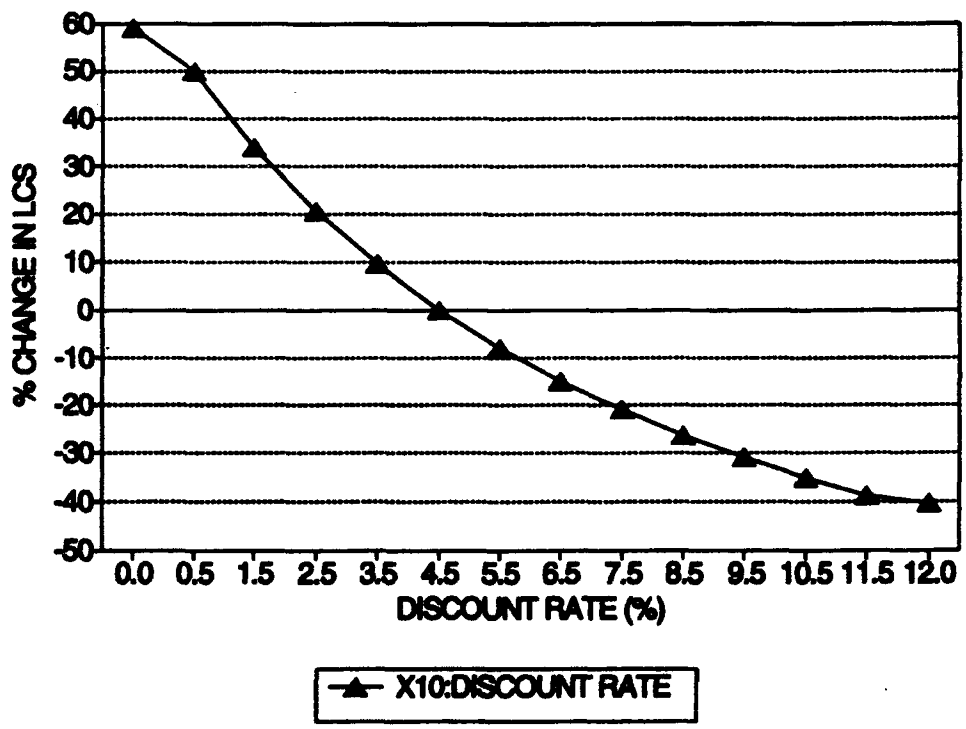

Figure 74. Effect of Discount Rate on the LCC of a Coal-Fired Stoker Plant, Picatinny Arsenal.

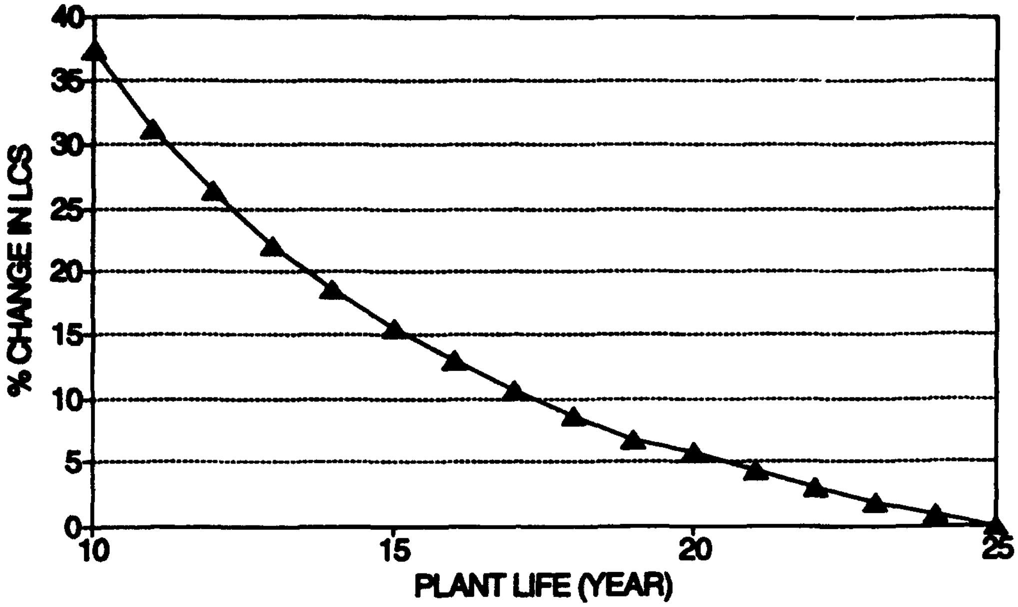

Figure 75. Effect of Plant Life on the LCC of a Coal-Fired Stoker Plant, Picatinny Arsenal.

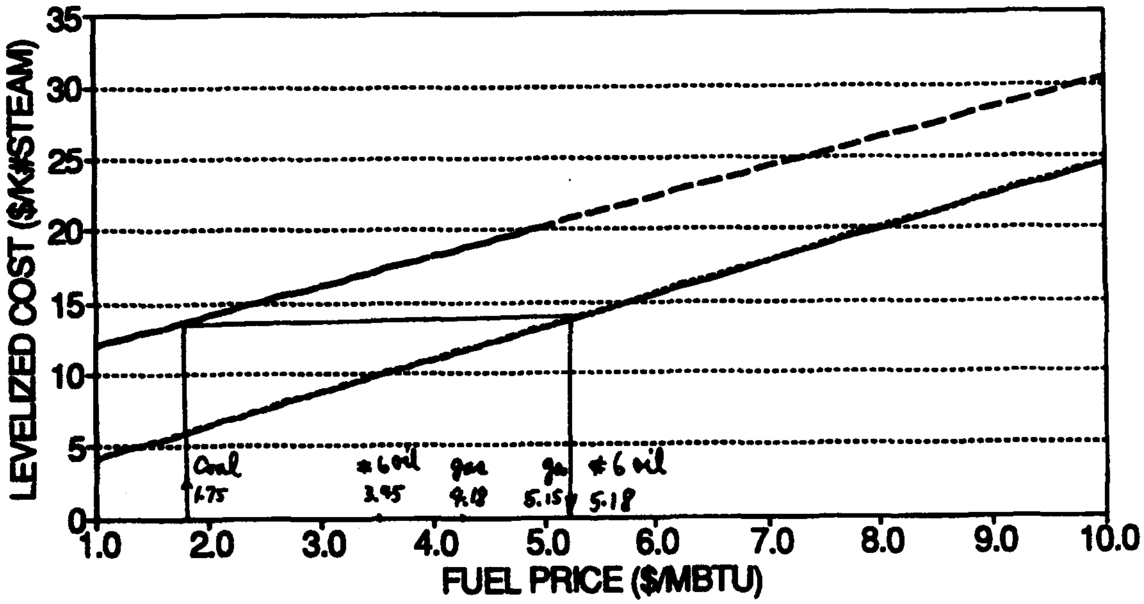

Figure 76. Leveled Cost of Service vs. Fuel Price; Picatinny Arsenal.

APPENDIX C: 1989 Installation Energy Consumption Report

ADDS REPORT: RANKING
COVERS : FROM JAN89 THRU DEC89
INCLUDES : ALL MACOMS
INSTALLATION RANKING BY CONSUMPTION - TOTAL FACILITY

RANK		MBTUS
1	VII CORPS STUTTGART	9,475,618
2	V CORPS, FRANKFURT	8,261,431
3	FORT RICHARDSON	5,220,795
4	RADFORD ARMY AMMO PLANT	3,960,608
5	HOLSTON ARMY AMMO PLANT	3,801,610
6	21ST SUPCOM	3,760,975
7	FORT BRAGG	3,117,543
8	FORT HOOD	2,873,759
9	FORT KNOX	2,718,746
10	FORT BENNING	2,717,107
11	Aberdeen PG	2,541,672
12	FORT LEWIS	2,515,574
13	FORT CAMPBELL	2,425,919
14	REDSTONE ARSENAL	2,195,256
15	FORT RILEY	1,937,176
16	FORT ORD	1,874,942
17	FORT DIX	1,793,491
18	FORT GEORGE MEADE	1,719,846
19	FORT CARSON	1,706,884
20	FORT BLISS	1,655,909
21	FORT SILL	1,649,784
22	FORT LEONARD WOOD	1,646,571
23	SUNFLOWER ARMY AMMO PLANT	1,613,163
24	FORT STEWART	1,601,289
25	FORT DRUM	1,536,908
26	FORT BELVOIR	1,351,474
27	FORT JACKSON	1,342,532
28	ROCK ISLAND ARSENAL	1,296,026
29	WEST POINT	1,289,720
30	WALTER REED ARMY MEDICAL CENTE	1,254,489
31	FORT DEVENS	1,240,232
32	PICATINNY ARSENAL	1,229,515
33	FORT GORDON	1,224,015
34	7TH ATC, GRAFENWOHR	1,211,465
35	FORT POLK	1,177,156
36	FORT SAM HOUSTON	1,090,090
37	PRESIDIO OF SAN FRANCISCO	966,007
38	FORT RUCKER	952,015
39	FORT MONMOUTH	934,401
40	PINE BLUFF ARSENAL	930,685
41	FORT MCCLELLAN	914,909
42	FORT EUSTIS	907,831
43	DETROIT ARSENAL	891,238
44	LAKE CITY ARMY AMMO PLANT	881,996
45	FORT LEAVENWORTH	868,345
46	RED RIVER ARMY AMM0 DEPOT	867,540
47	FORT BENJAMIN HARRISON	842,345
48	FORT HUACHUCA	821,486
49	STRATFORD ARMY ENGINE PLANT	774,041
50	CAMP CASEY, KOREA	756,734
51	LONE STAR ARMY AMMO PLANT	747,764
52	IOWA ARMY AMMO PLANT	745,734
53	FORT LEE	725,970
54	Anniston Army Depot	700,806
55	26TH SPTGRP, HEIDELBERG	668,308
56	WHITE SANDS MISSLE RANGE	666,540

57	MISSISSIPPI ARMY AMMO PLANT	665,458
58	WATERVLIET ARSENAL	661,868
59	TOBYHANNA ARMY DEPOT	646,374
60	FORT MCCOY	646,369
61	USAB (BERLIN)	645,700
62	FORT DIETRICK	630,684
63	FORT SHERIDAN	609,520
64	TOOELE ARMY DEPOT	601,416
65	FORT CLAYTON	586,557
66	FITZSIMONS ARMY MEDICAL CENTER	569,836
67	FORT SHAFTER	567,595
68	CAMP ZAMA JAPAN	556,025
69	LONGHORN ARMY AMMO PLANT	543,813
70	LIMA ARMY TANK PLANT	527,248
71	LETTERKENNY ARMY DEPOT	509,376
72	FORT MCPHERSON	484,372
73	LOUISIANA ARMY AMMO PLANT	478,393
74	SETAF/5TH SUPCOM, VICENZA	450,879
75	NEW CUMBERLAND ARMY DEPOT	432,960
76	FORT HAMILTON	414,203
77	FORT IRWIN	409,088
78	SCRANTON ARMY AMMO PLANT	403,900
79	FORT MYER	400,128
80	Charleston	345,633
81	CORPUS CHRISTI ARMY DEPOT	341,924
82	MTMC MOT BAYONNE	336,471
83	FORT RITCHIE	336,323
84	DUGWAY PROVING GROUND	315,211
85	MCALISTER ARMY AMMO PLANT	303,012
86	USA FDSK	289,543
87	JOLIET ARMY AMMO PLANT	279,146
88	Norfolk	264,526
89	LEXINGTON BLUEGRASS ARMY DEPOT	261,240
90	RIVERBANK ARMY AMMO PLANT	260,607
91	TWIN CITIES ARMY AMMO PLANT	259,886
92	New Orleans	253,040
93	KANSAS ARMY AMMO PLANT	252,916
94	HARRY DIAMOND LAB	250,856
95	Memphis	241,621
96	SACRAMENTO ARMY DEPOT	237,383
97	FORT CHAFFEE	231,468
98	CARLISLE BARRACKS	230,078
99	PUEBLO DEPOT ACTIVITY	228,781
100	Baltimore	227,760
101	HAWTHORNE AAP	218,533
102	FORT MONROE	202,581
103	MILAN ARMY AMMO PLANT	199,012
104	Vicksburg	190,291
105	INDIANA AAP	182,625
106	ROCKY MOUNTAIN ARSENAL	180,873
107	CAMERON STATION	180,853
108	MICHIGAN ARNG	179,729
109	SENECA ARMY DEPOT	175,371
110	ST LOUIS AREA SUPPORT CENTER	171,058
111	St. Louis	165,891
112	USA NATICK RD & E CENTER	156,968
113	VINT HILL FARMS STATION	150,481
114	WES	145,831
115	Mobile	139,117
116	MATERIALS TECHNOLOGY LAB	131,041
117	YUMA PROVING GROUND	128,895
118	SAVANNAH DEPOT ACTIVITY	128,584
119	ARKANSAS ARNG	128,538
120	CALIFORNIA ARNG	125,851
121	SIERRA ARMY DEPOT	118,299
122	MTMC WESTERN AREA	111,840

123	SHARPE ARMY DEPOT	109,986
124	MISSISSIPPI ARNG	103,051
125	Philadelphia	101,658
126	FORT BUCHANAN	99,093
127	INDIANA ARNG	93,468
128	FORT MCNAIR	85,073
129	ARLINGTON HALL STATION	80,319
130	NEWPORT ARMY AMMO PLANT	79,686
131	NEW YORK ARNG	77,991
132	Rock Island	76,629
133	MINNESOTA ARNG	73,709
134	PENNSYLVANIA ARNG	71,281
135	RAVENNA ARMY AMMO PLANT	71,167
136	HEC	69,205
137	NEW JERSEY ARNG	63,078
138	ALABAMA ARNG	62,884
	JEFFERSON PROVING GROUND	62,884
139	IDAHO ARNG	62,454
140	Wilmington	60,550
141	MASSACHUSETTS ARNG	59,886
142	Detroit	58,148
143	Little Rock	57,759
144	OKLAHOMA ARNG	57,185
145	ALASKA ARNG	57,014
146	USAGO MAKIMINATO RYUKYU I	53,117
147	UTAH ARNG	52,925
148	TENNESSEE ARNG	52,815
149	FIELD STATION KUNIA WHEEL	51,558
150	IOWA ARNG	51,369
151	Omaha	50,544
152	Huntington	48,294
153	GEORGIA ARNG	46,796
154	CONNECTICUT ARNG	46,358
155	CRREL	44,255
156	NORTH DAKOTA ARNG	43,787
157	BADGER AAP	43,072
158	OREGON ARNG	42,999
159	WISCONSIN ARNG	42,548
160	ILLINIOS ARNG	41,813
161	125TH ARCOM	40,591
162	Pittsburgh	38,517
163	OHIO ARNG	37,413
164	Kansas City	37,304
165	UMATILLA DEPOT ACTIVITY	36,955
166	LOUISIANA ARNG	36,596
167	FLORIDA ARNG	34,938
168	MISSOURI ARNG	33,548
169	VERMONT ARNG	32,363
170	KANSAS ARNG	31,854
171	Louisville	31,074
172	MONTANA ARNG	30,961
173	TULSA	30,707
174	New York	30,636
175	WASHINGTON ARNG	29,659
176	TEXAS ARNG	29,253
177	KENTUCKY ARNG	28,860
178	RHODE ISLAND ARNG	27,740
179	PUERTO RICO ARNG	27,525
180	USA CERL	26,930
181	ARIZONA ARNG	26,168
182	MAINE ARNG	25,857
183	NEW MEXICO ARNG	25,855
184	COLORADO ARNG	25,332
185	VIRGINIA ARNG	25,031
186	MARYLAND ARNG	24,876
187	Walla Walla	24,845

188	WYOMING ARNG	23,131
189	NORTH CAROLINA ARNG	23,023
190	WEST VIRGINIA ARNG	22,840
191	SOUTH CAROLINA ARNG	22,242
192	FORT WINGATE DEPOT ACTIVITY	21,617
193	NEBRASKA ARNG	21,509
194	ST. LOUIS AAP	21,281
195	SOUTH DAKOTA ARNG	21,061
196	NEVADA ARNG	20,401
197	Buffalo	19,326
198	DELAWARE ARNG	18,689
199	Fort Worth	17,531
200	Sacramento	17,208
201	81ST ARCOM	15,591
202	MOT SUNNY POINT	15,101
203	89TH ARCOM	15,078
204	CORNHUSKER AAP	14,355
205	NED	13,949
206	Seattle	12,352
207	VOLUNTEER ARMY AMMO PLANT	12,342
208	Nashville	12,183
209	NEW HAMPSHIRE ARNG	9,710
210	San Francisco	9,248
211	St. Paul	8,416
212	USAMED	7,422
213	ALBUQUERQUE	7,051
214	DISTRICT OF COLUMBIA ARNG	5,637
215	Jacksonville	3,720
216	GUAM ARNG MARIANAS ISLANDS	3,239
217	PONTIAC STORAGE FACILITY	3,238
218	LOS ANGELES	2,672
219	HAWAII ARNG	2,644
220	Galveston	2,367
221	VIRGIN ISLANDS ARNG	2,034
222	Alaska	1,011
223	Chicago	78
224	RESERVES	0
	FORT A.P. HILL	0
		===========
		130,082,527

APPENDIX D:

CHPECON Input

FROM SCREENING MODELS

NEW PLANT SCREENING OPTION
Select State, Base, Emission regulation region
Type of boiler system (steam/HTHW)
Process load (MBtu/hr)
Average monthly steam flow (MBtu/hr)
Internal boiler house leak percentage (0-5)
Blowdown percentage (0-10)
Condensate return percentage (0-100)
Condensate return temperature (degrees F)
Makeup water temperature (degrees F)
Boiler technology (Choose one)
Number of boilers (3, 4, 5)
Coalfield-distance search, choose field
Days of long term coal storage (60-100)
Days of short term coal storage (1-3)
Coal pile arrangement (single/multiple)
Rail car thawing shed needed (yes/no/maybe)
Rail transport available for coal/limestone (y/n/m)
Highway transport available for coal/lime (y/n/m)
Are there available sites for ash disposal (A) No landfill is on or near base; B) Landfill is near base; C) Landfill is on base, not adjacent to site; D) Landfill is on base, adjacent to site)
Local sewage disposal of boiler water discharge (y/n/m)
Transport of coal/ash through community/base feasible (y/n/m)
Local resistance to new boiler plant (y/n/m)
Sufficient city water for makeup (y/n/m)
New electrical substation required (y/n/m)
Lime available (y/n/m)
How accessible is steam distribution system (A) Routing is very long and/or difficult to access; B) Routing is fairly accessible and medium length; C) Routing is short and accessible)
Condition of steam distribution system (Poor, Fair, Good)
Does base have its own supply of natural gas (y/n/m)
Does a local utility supply natural gas (y/n/m)
Is natural gas supply interruptible (y/n/m)
Can a firm delivery contract be established (y/n/m)
Natural gas pipeline have sufficient capacity (y/n/m)
Price of natural gas less than price of #2 fuel oil on an equivalent energy basis (y/n/m)
Is low sulfur fuel oil (#2 or #6) available (y/n/m)
Price of #2/#6 fuel oil less than price of natural gas on an equivalent energy basis (y/n/m)

NEW PLANT WITH COGENERATION SCREENING OPTION
Average and peak electricity loads for each month (kW)
Cogenerated electricity generation efficiency (%)
How many hours per year will plant be operated (A) <4000 hours, B) 4000-6000 hours, C) >6000 hours)

Can/does existing electrical system use a single point supply and metering station near the proposed cogeneration site so cogenerated power can displace purchased power (y/n/m)
Will base see reduction of thermal or electric load in near future (y/n/m)
Will utility supply service to maintain and repair interconnection facilities (y/n/m)
Local utility cooperative in setting interconnections and standby power cost (y/n/m)
Local utility use coal (y/n/m)
Present electric rate ($/kWh)
Anticipated cost of fuel ($/MBtu)
Facilities electric load: a.<25 MW, b.25-50 MW, c.>50 MW

Facilities load factor: a.<30%, b.30-40%, c.>40%
Base annual electric power to steam power ratio: a.<35 kWh/MBtu, b.35-75 kWh/MBtu, c.>75 kWh/MBtu
Base average ratio of hourly electric to steam power ratio:
a.<35 kWh/MBtu, b.35-75 kWh/MBtu, c.>75 kWh/MBtu

THIRD PARTY COGENERATION OPTION
Process load (MBtu/hr)
Cogeneration electricity-generation efficiency (%)
What is the cost of thermal energy provided by the base ($/MBtu)
What is the expected cost of thermal energy provided to base by a third party cogenerator ($/MBtu)
What is the current thermal demand of the base (A) ≥500,000 lb/hr; B) 500,000 ≥ x ≥ 200,000 lb/hr; C) ≤200,000 lb/hr)
How many hours per year is third party cogeneration facility expected to be operated (A) ≤4000; B) 4000 to 5999; C) 6000 to 8760)
Will significant electric generation capacity be consistently available between 8 AM and 6 PM (y/n/m)
Will significant electric generation capacity be consistently available from July 1 to September 15 (y/n/m)
What is the expected cost of electricity that will be produced by the third party cogeneration facility, given today's fuel prices (cents/kWh)
What is the current rate of electricity experienced by the base (cents/kWh)
If the cogeneration facility will supply the base with electricity as well as thermal energy, what is the most likely rate that the cogenerator will offer the base (cents/kWh)
Is the local utility capacity-constrained (y/n/m)
Is wheeling of cogenerated electricity to other demand centers a realistic alternative to local buy-backs (y/n/m)
Does the existing CHP require retrofit/repair/expansion (y/n/m)
Will the thermal output of the facility be at least 5% of the total energy output (y/n/m)
Will electric power output + 0.5 of the useful thermal energy output be at least 42.5% of the fuel heat input if the useful thermal energy is at least 15% of the total, and at least 45% otherwise (y/n/m)

CONSOLIDATION OPTION
Does the base have a relatively flat thermal load profile during the typical day (y/n/m)
Enter the area to be served by the proposed distribution system (acres)
Can you convince the base commander and existing building operators of the advantages of a CHP (y/n/m)
Do the existing buildings utilize steam or HTW for heating (y/n/m)
Does the base have a process steam load which requires steam greater than 200 psi (y/n/m)

RETROFIT SCREENING OPTION
Boiler sizes (lb. steam/hour)
Are feedwater pumps, deaerator, condensate system, and raw water treatment adequate and in a good state of repair (y/n/m)
Does the facility have adequate electric substation to support the modification technology (y/n/m)
Is there room to install ash handling system (y/n/m)
Is there room to install air pollution control equipment (y/n/m)
Is there room to install new combustion control system (y/n/m)
Is there room to install fuel burning equipment (y/n/m)
Can the boiler be retrofitted without major boiler/equipment modifications (y/n/m)
Does the boiler house allow boiler(s) retrofit without major structural change (y/n/m)
Is the stack suitable for use (y/n/m)
Is the auxiliary fuel system adequate to support retrofit technology (y/n/m)
Does the facility/boiler require major repairs or replacement not related to retrofit (y/n/m)
Does the boiler house have a basement (y/n/m)
Is the soot blowing system in proper working order (y/n/m)

Is existing ash handling equipment available (a/b/c)
Is existing coal handling equipment available (a/b/c)

FROM COSTING MODELS

NEW PLANT COSTING
Years plant is to be operated (maximum of 25)
Current discount rate (%)
Net salvage value of current system ($)
What % of Adjusted Investment Cost is the net salvage value of the new or retrofit system
What is the year of the study
What year will the facility start operation
Escalation factors (choices given)
Coal transport cost (cents/ton-mile)
Coal transport cost escalation rate (%)
Apply 10% investment cost exclusion (y/n)
Water cost ($/1000 gallons)
Non-potable water cost ($/1000 gallons)
Sewer cost ($/1000 gallons)
Ash waste disposal ($/ton)
Lime cost ($/ton)
Cost of coal; distillate oil; residual oil; electricity; natural gas; (defaults given)
Is a desuperheater required (y/n/m)
Coal transport by truck, rail, both (t/r/b)
Should a stock/reclaim system be included (y/n/m)
Include a coal silo (y/n/m)
Storage time for silo (1-7 days)
Dry scrubber and lime: days of storage required (3-28 days)
Include a mixed-bed for condensate polishing (y/n/m)
Include a dealkalizer unit (y/n/m)
Required storage for condensate storage tank (1-4 hours)
Amount of water in ash waste (1-50%)

NEW PLANT WITH COGENERATION COSTING
Steam load: (1) to meet electricity load; 2) to follow heat/process load)
Should non-potable water be used for cooling tower and ash conditioning (y/n/m)

THIRD PARTY COGENERATION COSTING
See New Plant Costing

CONSOLIDATION COSTING
Select the type of steam system design (A) Tunnel construction; B) Direct Burial; C) Shallow trench/walkway construction; D) Above ground single stanchion construction)
Enter dimensions of steam distribution system (ft x ft; # of connections)

APPENDIX E:

CHPECON Screening Model Report

```
****************************************************************************************
**   Central Heating Plant Economics Evaluation Program                    Page 1   **
**   File: F1            Type: New plant (NP)                              09/21/92  **
**   Desc: FORT CAMPBELL                                                             **
**   Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection                        **
****************************************************************************************

State    : KY - Kentucky
Location :  36d  7m -  86d 41m
County   :
Emission regulation region
#  0 -  State and federal only

Annual heating degree days:  4166

*************************** Boiler Characteristics ***************************

Type of heating system : Steam

Average Monthly Steam Flows (million Btu/hr)

              Jan      Feb      Mar      Apr      May      Jun
               79       98       72       60       39       40
              Jul      Aug      Sep      Oct      Nov      Dec
               40       36       33       50       65       82

Calculated PMCR: 188 thousand lb/hr steam      *** manual entry

Boiler technology: Dump Grate Spreader Stoker, w/ fly ash reinjection

Boiler sizes (thousand lb steam/hr) :
         1:  43     2:  73     3:  73     4:  73

**************************** Coalfield Properties ****************************

Coalfield state : IN - Indiana
Coal code: W193122                   desc: MS NO 2 PIT
Distance from base:   140 miles
Located at  38d 05m 34s -  87d 15m 44s
Cmmt:
Proximate Analysis                        Ultimate Analysis

     Rank          : Bituminous                Carbon    : 71.40 %
                                               Hydrogen :  5.00 %
     Moisture      :   8.60 %                  Sulfur    :  2.80 %
     Volatiles     :  37.60 % dry              Oxygen    :  9.10 %
     Fixed Carbon  :  52.10 % dry              Nitrogen  :  1.40 %
     Ash           :  10.30 % dry              Ash       : 10.30 %

     Hrdgrv Grind :    0.0
     Free Swell   :    4.0
     Hemisph Temp :   2327 deg F
     Heating Value (dry) : 12830 Btu/lb
```

```
*****************************************************************************
**   Coal Fired Boiler Evaluation Program                          Page 2   **
**   File: F1            Type: New plant (NP)                      09/21/92 **
**   Desc: FORT CAMPBELL                                                    **
**   Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection               **
*****************************************************************************

************************ Boiler Performance @ PMCR **************************

Heat input :   253 million Btu/hr
Coal input :   9.9 tons/hr (dry)
              10.8 tons/hr (incl moisture)
Blowdown   :   5 %

Temperature out of stack :   220 deg F
Gas flow from stack      :      88017 cubic feet/min
Steam pressure           :  150 psig
Steam temperature        :  367 deg F        enthalpy  : 1195.6 Btu/lb
Condensate return temp   :  150 deg F        enthalpy  :  118.8 Btu/lb
Makeup water temperature :   50 deg F        enthalpy  :   18.1 Btu/lb
Inlet water temperature  :   97 deg F        enthalpy  :   65.2 Btu/lb

************************* Boiler Emissions @ PMCR **************************

    147.97 lb/hr, NOx emissions (out stack)
    110.36 lb/hr, SOx emissions (out stack)
   2032.10 lb/hr, particulate emissions (from boiler)
   1625.68 lb/hr, particulate emissions (after settling chamber)
    243.85 lb/hr, particulate emissions (after mechanical collector)
     36.58 lb/hr, particulate emissions (after dry scrubber)
      0.18 lb/hr, particulate emissions (after baghouse - out stack)

Ash collected by emis equip @ pmcr:  24.4 tons/day

Total ash output @ pmcr:  24.4 tons/day

******************** Area and Water Requirements @ PMCR ********************

Building size : 12267 sq ft         Condensate Return      :    50 %
Plant area    :  1.73 acres         Boiler house leakage   :     2 %
Plant height  :    69 ft            Water requirements     :   250 gpm (est)
Stack height  :   173 ft            Railway track length   :   672 ft
Sewer dischrg :    50 gpm (est)     Lime needed            :  2145 lb/hr

Multiple coal piles for storage
          Long term  :    90 days long term storage, on    3.06 acres
          Short term :     3 days short term storage, on   0.21 acres

Total storage area (long + short + others) :   4.27 acres
Pond size :  0.37 acres

Car thawing shed required: No
```

```
******************************************************************************
**    Coal Fired Boiler Evaluation Program                         Page 3    **
**    File: F1            Type: New plant (NP)                    09/21/92   **
**    Desc: FORT CAMPBELL                                                    **
**    Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection               **
******************************************************************************

******************* Emission Regulation Evaluation @ PMCR ********************

This plant passed all emission regulations
 NOx:                 147.97         151.87  Regulation of: US
                                   emissions [lb/hr] = 0.6 * input [10^6 Btu/hr]

Part:                   0.18          12.66  Regulation of: US
                                   emissions [lb/hr] = 0.05 * input [10^6 Btu/hr]

 SOx:                 110.36         303.75  Regulation of: US
                                   emissions [lb/hr] = 1.2 * input [10^6 Btu/hr]

 SOx:                  90.01          90.00  Regulation of: US
                                   reduction = 90 %

 NOx:                 147.97         177.19  Regulation of: KY
                                   emissions [lb/hr] = 0.7 * input [10^6 Btu/hr]

Part:                   0.18          25.31  Regulation of: KY
                                   emissions [lb/hr] = 0.1 * input [10^6 Btu/hr]
```

************************ General Site Considerations ************************

Rail transport available: Yes
Highway transport available: Yes
No problems with transportation.
Score: 10

Location of ash disposal site: landfill near base
Ash disposal can be a problem. Further investigation should verify ash disposal possibilities.
Score: 5

Local sewer system available: Maybe
Local sewage facilities may not be available. Therefore, it may be difficult to dispose of boiler water.
Score: 5

Coal/ash transport feasible: Maybe
Transportation of coal and/or ash might impose problems.
Score: 5

Local community resistant to plant: Maybe
The impact of community resistance might impose problems.
Score: 5

City water available: Maybe
Additional efforts and costs may be required to establish a water supply which are not considered in the detailed evaluation section of this program.
Score: 5

New electrical substation required: Maybe
Additional effort and expense may be required to construct a new substation.
Score: 2

Lime available: Maybe
Lime is required in the dry scrubbers for the stokers. Therefore, a more thorough investigation on the availability of a lime supply should be performed before considering a detailed plant evaluation or another combustion technology or fuel type should be considered.
Score: 5

Steam distribution system routing is medium
It may be difficult to incorporate the existing distribution system into the new plant. Additional costs may be required heavily modify the existing distribution system. These costs are not considered in the new plant detailed evaluation section of this program.
Score: 2

```
Condition of system is fair
Additional costs may be required to install a new distribution system.
These costs are not considered in the detailed evaluation program.
  Score:   3

Boiler technology rating:   10

Feasibility score: 57/95  =  60%
```

APPENDIX F:

CHPECON Costing Model Report (Long Form)

File: F1 Type: New plant (NP) 09/21/92

Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****

Base Information
****

State: KY - Kentucky Base DOE Region: 3
PMCR: 188,000 lb/hr steam Number of boilers: 4

Steam Properties: 150 psi (1195.6 Btu/lb)
Inlet water temp: 97 deg F enthalpy: 65.2 Btu/lb

Coalfield:
Coal code: W193122 desc: MS NO 2 PIT
State: IN - Indiana Distance from base: 140 miles
Coal type: bituminous (properties on a dry basis)
hhv: 12830 Btu/lb fixed carbon: 52.10% volatiles: 37.60%
ash: 10.30% sulfur: 2.80%
Coalfield DOE Region: 2

****

Boiler Design Parameters
****

A desuperheater IS required
A stock/reclaim system SHOULD BE included
A coal silo IS needed
Storage required for coal silo: 3 days
Selected method for coal transport is by BOTH RAIL AND TRUCK
Ash silo diameter: 20 feet
Number of ash silos: 1
Required lime storage: 14 days
A mixed bed for condensate polishing IS REQUIRED
A dealkalizer unit IS INCLUDED
Storage required for the condensate storage tank: 1 hours
Fraction of water in the ash waste generated: 10 %

File: F1 Type: New plant (NP) 09/21/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****

Plant Design Parameters --- Space Requirements
****

Approx. building width: 66 feet
Approx. building length: 185 feet
Air compressor flow rate: 219 cfm
Diesel generator capacity: 500 kW
Fuel storage area: 4.27 acres
Coal pile runoff pond area: 0.37 acres
Height of the plant: 69 ft
Building area: 12267 sq ft
Plant area: 1.73 acres

****

Plant Design Parameters --- Material Handling Specifications
****

Coal handling equipment capacity: 100 tons/hr
Coal silo storage capacity: 713 tons
Fly ash pipe size: 4 inches
Bottom ash pipe size: 6 inches
Total ash collected: 58 tons/day
Total gas flow: 294263 lbs/hr
Fly ash intake: 2 tons/day
Bottom ash intake: 2 lbs/hr
Ash silo capacity: 231 tons
Lime silo storage capacity: 397 tons
Number of facility fuel oil tanks: 1
Acid and caustic storage tank volume: 13537 gallons

****

Plant Design Parameters --- Water & Water Treatment Specifications
****

Number of deaerators: 2
Number of resin vessels / train: 1
Number of mixed beds / train: 1
Condensate storage tank size: 11285 gallons
Water storage tank size: 189580 gallons
Number of water treatment trains: 2
Boiler 1: 1 motor-driven feedwater pump -- 83 gpm
Boiler 1: 1 turbine-driven feedwater pump -- 83 gpm
Boiler 2: 1 motor-driven feedwater pump -- 141 gpm
Boiler 2: 1 turbine-driven feedwater pump -- 141 gpm
Boiler 3: 1 motor-driven feedwater pump -- 141 gpm
Boiler 3: 1 turbine-driven feedwater pump -- 141 gpm
Boiler 4: 1 motor-driven feedwater pump -- 141 gpm
Boiler 4: 1 turbine-driven feedwater pump -- 141 gpm
Annual dry scrubber water use: 1,771,215 gallons
Annual personnel water use: 236,250 gallons

File: F1 Type: New plant (NP) 09/21/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****

Facility Capital Costs
****

Boiler capital costs: $ 10,335,163
Boiler #1 (43 k-lb stm/hr) cost: $ 2,118,713
Boiler #2 (73 k-lb stm/hr) cost: $ 2,735,878
Boiler #3 (73 k-lb stm/hr) cost: $ 2,735,878
Boiler #4 (73 k-lb stm/hr) cost: $ 2,735,878
Desuperheater cost: $ 8,815

Coal Handling Capital Costs: $ 4,746,004
Rail/truck receiving cost: $ 2,192,748
Car dumper installed cost: $ 2,487,083
Coal pond cost: $ 21,311
Coal silo cost: $ 44,860

Ash handling system capital costs: $ 527,457
Ash piping system cost: $ 87,583
Air operated branch line gate cost: $ 12,125
Air operated fly ash intake cost: $ 74,046
Mechanical exhauster cost: $ 111,506
Manual bottom ash intake cost: $ 4,407
Receiver cost: $ 44,073
Mixer and unloader cost: $ 155,151
Control cost: $ 38,563

Mechanical Collector Capital Costs: $ 142,214
cost of collector #1 : $ 30,910
cost of collector #2 : $ 37,101
cost of collector #3 : $ 37,101
cost of collector #4 : $ 37,101

Dry scrubber and lime system capital costs: $ 1,960,918
cost of dry scrb/lime sys #1 : $ 339,770
cost of dry scrb/lime sys #2 : $ 339,770
cost of dry scrb/lime sys #3 : $ 339,770
cost of dry scrb/lime sys #4 : $ 339,770
Lime silo equipment cost: $ 262,068

Baghouse and ID fan capital costs: $ 1,804,867
Cost of baghouse #1 : $ 366,276
Cost of ID fan #1 : $ 22,936
Cost of baghouse #2 : $ 445,003
Cost of ID fan #2 : $ 26,880
Cost of baghouse #3 : $ 445,003
Cost of ID fan #3: $ 26,880
Cost of baghouse #4 : $ 445,003
Cost of ID fan #4 : $ 26,880

Boiler Water Treatment System Capital Costs: $ 707,707
Cost of zeolite softeners: $ 48,963
Cost of dealkalizers: $ 319,551

File: F1 Type: New plant (NP) 09/21/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

****

Facility Capital Costs, cont

****

Cost of mixed bed for condensate polishing: $ 226,253
Cost of chemical injection skid: $ 22,037
Cost of water lab: $ 22,037
Cost of 2 deaerators: $ 68,863

Tank Capital Costs: $ 445,201

Pump Capital Costs: $ 171,721

Air compressor capital costs: $ 60,277

Waste Water Treatment System Capital Costs: $ 70,911
Sanitary system cost: $ 37,243
Pond neutralization cost: $ 9,923
Storm sewer system cost: $ 23,743

Piping and Stack System Capital Costs: $ 2,512,048
Water/steam piping cost: $ 1,035,770
Facility stack cost: $ 1,476,277

Instrumentation Capital Costs: $ 881,507
Cost of heating/cogen control system: $ 220,376
Cost of emission monitors: $ 661,130

Electrical System Capital Cost: $ 1,045,298
Cost of backup diesel generation system: $ 56,802
Cost of substations: $ 929,328

Spare Parts, Tools and Mobile Equipment Capital Costs: $ 1,357,713
spare parts basis = equipment cost (unescalated): $ 23,061,686

Building and service capital costs: $ 5,273,923
Building costs: $ 4,430,133
Elevator costs: $ 165,282
Miscellaneous building costs: $ 343,683
Site development / improvement costs: $ 231,312
Cost of fuel storage area development: $ 103,510

File: F1 Type: New plant (NP) 09/21/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reir_ection

****

Facility Installation Costs

****

Boiler Installation costs: $ 2,721,259
Direct labor cost: $ 727,889
Indirect cost: $ 545,917
Freight cost: $ 206,703
Bulk material cost: $ 1,240,748

Coal Handling Installation Costs: $ 1,373,625
Direct labor cost $ 323,888
Indirect cost $ 242,916
Freight cost $ 94,920
Bulk material cost $ 711,900

Ash Handling Installation Costs: $ 2,602,879
Direct labor cost: $ 1,345,699
Indirect cost: $ 1,009,274
Freight cost: $ 10,549
Bulk material cost: $ 237,356

Mechanical Collector Installation Costs: $ 30,858
Direct labor cost: $ 11,945
Indirect cost: $ 8,958
Freight cost: $ 2844
Bulk material cost: $ 7,110

Dry Scrubber and Lime System Installation Costs: $1,514,550
Direct labor cost: $ 427,783
Indirect cost: $ 320,837
Freight cost: $ 39,218
Bulk material cost: $ 726,712

Baghouse and ID Fan Installation Costs: $ 985,474
Direct labor cost: $ 259,641
Indirect cost: $ 194,730
Freight cost: $ 36,097
Bulk material cost: $ 495,004

Boiler Water Treatment System Installation Costs: $ 434,554
Direct labor cost: $ 116,378
Indirect cost: $ 87,283
Freight cost: $ 14,154
Bulk material cost: $ 216,738

Tank Installation Costs: $ 287,801
Direct labor cost: $ 113,164
Indirect cost: $ 84,873
Freight cost: $ 8,904
Bulk material cost: $ 80,858

Pump installation costs: $ 82,902

Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

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Facility Installation Costs, cont

****

Direct labor cost: $ 24,471
Indirect cost: $ 18,353
Freight cost: $ 3,434
Bulk material cost: $ 36,643

Air Compressor Installation Costs: $ 31,273
Direct labor cost: $ 5,126
Indirect cost: $ 3,844
Freight cost: $ 1,205
Bulk material cost: $ 21,097

Waste Water Treatment System Installation Costs: $ 60,089
Direct labor cost: $ 25,655
Indirect cost: $ 19,241
Freight cost: $ 1,418
Bulk material cost: $ 13,773

Piping and Stack System Installation Costs: $ 2,225,710
Direct labor cost: $ 879,704
Indirect cost: $ 659,778
Freight cost: $ 50,240
Bulk material cost: $ 635,987

Instrumentation Installation Costs: $ 613,291
Direct labor cost: $ 101,111
Indirect cost: $ 75,833
Freight cost: $ 17,630
Bulk material cost: $ 418,715

Electrical System Installation Costs: $ 800,435
Direct labor cost: $ 254,377
Indirect cost: $ 190,782
Freight cost: $ 20,905
Bulk material cost: $ 334,369

Spare Parts, Tools, Mobile Equipment Installation Costs: $ 27,154
Freight cost: $ 27,154

Building Costs: $ 1,287,398
Direct labor cost: $ 106,810
Indirect cost: $ 80,107
Freight cost: $ 103,408
Bulk material cost: $ 997,072

File: F1 Type: New plant (NP) 09/21/92

Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

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Direct Costs
****

Direct costs: $ 14,328,324
- Permit development cost: $ 807,736
- Engineering cost: $ 3,845,152
- Construction management cost: $ 2,243,005
- Construction contigency cost: $ 4,806,440
- Owners management cost: $ 2,336,329
- Startup cost: $ 289,660

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Installed Capital Equipment Cost Summary
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Total Capital Costs: $ 32,042,935
Total Direct labor cost: $ 4,723,647
Total Indirect cost: $ 3,542,735
Total Freight cost: $ 638,788
Total Bulk material cost: $ 6,174,089
Total Direct costs: $ 14,328,324

Plant installed cost: $ 61,450,519

File: F1 Type: New plant (NP) 09/21/92

Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

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Facility Operating Labor Requirements

****

Operation personnel requirements
- plant manager: 1
- plant engineer: 1
- plant technician: 1
- plant clerk: 1
- plant secretary: 1
- plant janitor: 1
- operations operator: 6
- operations assistant operator: 3
- operations laborer: 2
- fuel storage operator equipment: 1
- fuel storage assistant operator: 1
- fuel storage laborer: 2
- maintenance a mechanic: 3
- maintenance a electrician: 2
- maintenance laborer: 1

Operating staff: 27

Annual Labor Costs: $ 1,185,309

File: F1 Type: New plant (NP) 09/21/92

Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

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Yearly O & M Costs Summary

****

Annual boiler maintenance costs: $ 87,848
Annual spare parts costs (first year): $ 84,101
Annual spare parts costs (after first year): $ 476,573
Annual mobile equipment maintenance costs: $ 31,469
Annual facility consumables costs: $ 39,247
Annual O & M (materials/supplies) costs: $ 526,167
  Annual diesel/distillate fuel usage: 16,752 gallons
  Annual electricity usage: 3,722,308 kW-hr
  Annual lime cost: $ 230,257
  Annual condensate make-up water cost: $ 90,663
  Annual blowdown make-up water cost: $ 9,066
  Annual dry scrubber water cost: $ 5,313
  Annual ash conditioning water cost: $ 217
  Annual facility washdown water cost: $ 2,340
  Annual condensate polisher water cost: $ 3,812
  Annual zeolite softener water cost: $ 2,897
  Annual personnel water cost: $ 708
  Annual chemicals cost: $ 2,997
  Annual sanitary sewer cost: $ 3,790
  Annual ash disposal cost: $ 151,577
  Annual miscellaneous maintenance costs: $ 22,523
  Annual lime usage: 2,878 tons
Study year lime cost: $80.00/ton
Study year water cost: $3.00/1000 gallon
Study year ash disposal cost: $50.00/ton
Study year coal transportation cost: 2.18 cents/ton-mile
Study year cost transportation cost escalation rate: $0.00 %
  (escalation above general inflation)
1993 cost for coal: 1.530 $/MMBtu
1993 cost for distillate: 0.633 $/gallon
1993 cost for electricity: 0.047 $/kW-hr

File: F1 Type: New plant (NP) 09/21/92

Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

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Periodic Maintenance Costs Summary

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Major boiler maintenance costs (every 8 years): $ 310,054
Coal handling system maintenance costs (every 10 years): $ 474,600
Major ash handling system maintenance costs (every 7 years): $ 116,040
Major scrubber-lime system maintenance costs (every 5 years): $ 101,931
Lime conveyor system maintenance costs (every 5 years): $ 6,115
Major baghouse maintenance costs (every 3 years): $ 85,064
Major baghouse maintenance costs (every 12 years): $ 119,090
Major I.D. fan maintenance costs (every 20 years): $ 39,360
Major water treatment system maintenance costs (every 10 years): $ 267,645
Major deaerator maintenance costs (every 20 years): $ 17,215
Motor-driven feedwater pumps maint costs (every 15 years): $ 14,652
Turbine-driven feedwater pumps maint costs (every 12 years): $ 25,919
Centrifugal pump maint costs (every 18 years): $ 21,153
Sump pump maintenance costs (every 20 years): $ 13,652
Major stack maintenance costs (every 20 years): $ 14,762
Major building maintenance costs (every 20 years): $ 664,520
Periodic EPA permit testing/renewal costs (every 3 years): $ 30,000

File: F1 Type: New plant (NP) 09/21/92

Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

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Economic Data Summary

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Capital Equipment Escalation Factor: 1.102
based on Engineering News Record, Construction Cost Index: 5032.16

Non-Labor Operation & Maintenance Escalation Factor: 1.092
based on Chemical Engineering, M & S Index, Steam Power Comp: 935.60

Operation & Maintenance Labor Escalation Factor: 1.119
based on Engineering News Record, Skilled Labor Index: 4626.82

Construction Labor Escalation Factor: 1.024
based on Chemical Engineering, Construction Labor Index: 271.10

Annual Facility Output: 504,528 thousand lb steam
Steam enthalpy: 1195.6 Btu/lb
Inlet enthalpy: 65.1 Btu/lb
Annual Coal Usage: 26,568 tons (dry)
28,853 tons (wet)
Heating plant efficiency: 84%
Discount Rate: 4.0 %
Coal Transportation Cost: 2.18 cents/ton-mile
Coal Transportation Cost Escalation: 0.00 %
Year of Study: 1993
Years of Operation: 1997 - 2021
10% Investment Cost Exclusion IS NOT applied

File: F1 Type: New plant (NP) 09/21/92

Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

Cash Flow Summary

1996 adjusted investment: 61,450,519 existing plant salvage: 0

Year	Boiler Fuel & Tran	Auxiliary Energy	Non-Energy O&M	Repair and Replacement
1997	1,257,844	191,084	1,954,143	0
1998	1,272,650	192,961	2,346,616	0
1999	1,280,058	195,140	2,346,616	115,064
2000	1,302,271	199,739	2,346,616	0
2001	1,317,076	202,592	2,346,616	108,047
2002	1,331,881	205,272	2,346,616	115,064
2003	1,339,289	207,779	2,346,616	116,041
2004	1,361,491	210,113	2,346,616	310,055
2005	1,383,704	213,212	2,346,616	115,064
2006	1,413,315	214,226	2,346,616	850,293
2007	1,442,936	216,004	2,346,616	0
2008	1,479,955	217,274	2,346,616	175,010
2009	1,502,168	218,692	2,346,616	0
2010	1,524,370	220,531	2,346,616	116,041
2011	1,545,916	222,073	2,346,616	237,764
2012	1,567,790	223,629	2,346,616	310,055
2013	1,589,981	225,200	2,346,616	0
2014	1,612,511	226,784	2,346,616	136,217
2015	1,635,383	228,385	2,346,616	0
2016	1,658,593	229,999	2,346,616	1,599,804
2017	1,682,143	231,628	2,346,616	231,105
2018	1,706,056	233,130	2,346,616	0
2019	1,730,330	234,647	2,346,616	0
2020	1,754,968	236,180	2,346,616	485,065
2021	1,779,968	237,731	2,346,616	108,047

2022 new plant salvage: 0

File: F1 Type: New plant (NP) 09/21/92

Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

Life Cycle Cost Summary

+ PV 'Adjusted' Investment Costs	= $ 54,629,288
+ PV Energy + Transportation Costs	= $ 23,154,192
+ PV Annually Recurring O&M Costs	= $ 32,254,253
+ PV Non-Annually Recurring Repair & Replacement	= $ 2,537,619
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1993)	= $ 112,575,353

Levelized Cost of Service (1997 start) = 13.975 $/MMBtu
Levelized Cost of Service (1997 start) = 16.709 $/1000 lb steam

APPENDIX G:

CHPECON Costing Model Report (Short Form)

File: F1 Type: New plant (NP) 09/21/92
Desc: FORT CAMPBELL
Tech: Dump Grate Spreader Stoker, w/ fly ash reinjection

Base and Plant Information

State: KY - Kentucky Base DOE Region: 3
PMCR: 188,000 lb/hr steam Number of boilers: 4

Coal code: W193122 Distance from base: 140 miles
State: IN - Indiana DOE Region: 2
Coal type: bituminous (properties on a dry basis)
hhv: 12830 Btu/lb fixed carbon: 52.10% volatiles: 37.60%
ash: 10.30% sulfur: 2.80%

Coal handling equipment capacity: 100 tons/hr
Coal silo storage capacity: 713 tons
Approx. building width: 66 feet
Approx. building length: 185 feet
Height of the plant: 69 ft
Building area: 12267 sq ft
Plant area: 1.73 acres

Facility Parameters

Capital Equipment Escalation Factor: 1.102 (5032.16/1993)
Non-Labor Operation & Maintenance Escalation Factor: 1.092 (935.60/1993)
Operation & Maintenance Labor Escalation Factor: 1.119 (4626.82/1993)
Construction Labor Escalation Factor: 1.024 (271.10/1993)

Annual diesel/distillate fuel usage: 16,752 gallons
Annual electricity usage: 3,722,308 kW-hr
Annual lime usage: 2,878 tons

1993 cost for coal: 1.530 $/MMBtu
1993 cost for distillate: 0.633 $/gallon
1993 cost for electricity: 0.047 $/kW-hr

Annual Facility Output: 504,528 thousand lb steam
Annual Coal Usage: 26,568 tons (dry) / 28,853 tons (wet)
Heating plant efficiency: 84%
Year of Study: 1993
Years of Operation: 1997 - 2021

Facility Installed Capital Costs

Equipment		Cost	Equipment		Cost
Boiler:	$	13,056,422	Coal Handling:	$	6,119,630
Ash Handling:	$	3,130,337	Mechncl Collector:	$	173,073
Dry Scrubber/Lime:	$	3,475,468	Baghouse/ID Fan:	$	2,790,341

Facility Installed Capital Costs, cont

Water Treatment:	$	1,142,261	Pumps:	$	254,623
Air Compressor:	$	91,551	Waste Water Trtmnt:	$	131,000
Piping/Stack:	$	4,737,758	Electrical System:	$	1,845,734
Building Costs:	$	6,561,322	Direct costs:	$	14,328,324

Plant installed cost: $ 61,450,519

Facility Annual O & M and Energy Costs

Operating staff: 27
Annual Labor Costs: $ 1,185,309

First Year Non-Labor O & M Costs	: $	1,954,143
Annual Year Non-Labor O & M Costs	: $	2,346,616
1997 Coal Costs (incl transport)	: $	1,257,844
1997 Auxiliary Energy Costs	: $	191,084

Periodic Major Maintenance Cost Summary

Time Interval	Cost	Time Interval	Cost
3 years	$ 115,064	5 years	$ 108,047
7 years	$ 116,041	8 years	$ 310,055
10 years	$ 742,246	12 years	$ 59,946
15 years	$ 14,653	18 years	$ 21,153
20 years	$ 749,511		

Facility Life Cycle Cost Summary

+ PV 'Adjusted' Investment Costs	= $ 54,629,288
+ PV Energy + Transportation Costs	= $ 23,154,192
+ PV Annually Recurring O&M Costs	= $ 32,254,253
+ PV Non-Annually Recurring Repair & Replacement	= $ 2,537,619
+ PV Disposal Cost of Existing System	= $ 0
+ PV Disposal Cost of New/Retrofit Facility	= $ 0
Total Life Cycle Cost (1993)	= $ 112,575,353

Levelized Cost of Service (1997 start) = 13.975 $/MMBtu
Levelized Cost of Service (1997 start) = 16.709 $/1000 lb steam

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